ethereum

vienna

General Introduction

Project

Decentralisation of the web

Removing the role of central points

Takes away control from service owners

Data cannot just disappear

Data can only be modified by certain rules*

Censorship resistant

Server cannot freeze funds

* most of the time

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Web 3.0

Platform for decentralised applications (**DApps**)

Ethereum (Blockchain)

Consensus Layer

Whisper

Messaging and Broadcasting

Swarm / IPFS (Content System)

Data publication and distribution

DApps

Escrow Standard UI Wallet

Crowdfunding Weifund

Subscription Services (see workshop)

Prediction Markets Augur / Gnosis

Registries Namereg

Marketplace Safemarket

Decentralised Autonomous Organisations (DAO)

Stablecoins MakerDAO

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blockchain

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Blockchain

Public record of all transactions

Stored and processed by all full nodes

Determines order of transactions

Necessary to determine current state of the system

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Blockchain

Account based System

- identified by a 160 bit address
- has a balance of Ether / Wei

2 types of accounts

- "Accounts" (external)
- Contracts (internal)

Blockchain

Account (external)

user controlled account

controlled by a private key

can send and receiver ether

0x1350cf34d093953ce0d2803648da8f3b6a84de77	100
0xd5f9d8d94886e70b06e474c3fb14fd43e2f23970	2500
0xd2963cd505c94dbf3bc663bdd2321bd3000204bb	23290
0xd2963cd505c94dbf3bc663bdd2321bd3000204bb	123809
…	…

Blockchain

Contract (internal)

Controlled by code (EVM byte-code)

Gets executed whenever it receives a message

Ether can only be sent out by the code

Persistent storage to preserve state across txs

Can send other messages during its execution

```
DUP2 SWAP1 SSTORE POP DUP5 DUP5 POP PUSH1 0x6 ADD
PUSH1 0x0 SWAP1 SLOAD SWAP1 PUSH2 0x1 0x0 EXP
SWAP1 DIV PUSH1 0xff AND PUSH2 0x6 0x88 JUMPI DUP5
DUP5 POP PUSH1 0x1 ADD PUSH1 0x0 POP SLOAD DUP4 LT
ISZERO PUSH2 0x5 0x8e JUMPI PUSH2 0x6 0x83 JUMP
JUMPDEST DUP5 DUP5 POP PUSH1 0x0 ADD PUSH1 0x0
```

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Blockchain

Code written in an ethereum specific language

- Solidity

high level

official language

- lll

lisp-like (low level)

- EVM Assembly

```
contract Coin {

    event Transfer(address indexed from, address indexed to);

    mapping (address => uint) public balances;

    function() {
        balances[msg.sender] = 10;
    }

    function Send(address to, uint amount) {
        if(balances[msg.sender] >= amount) {
            balances[msg.sender] -= amount;
            balances[to] += amount;
        }
    }
}
```

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Blockchain

```
contract Coin {
    event Transfer(address indexed from, address indexed to);

    mapping (address => uint) public balances;

    function() {
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    function Send(address to, uint amount) {
        if(balances[msg.sender] >= amount) {
            balances[msg.sender] -= amount;
            balances[to] += amount;
        }
    }
}
```

token contract

persistent storage
use to store balance

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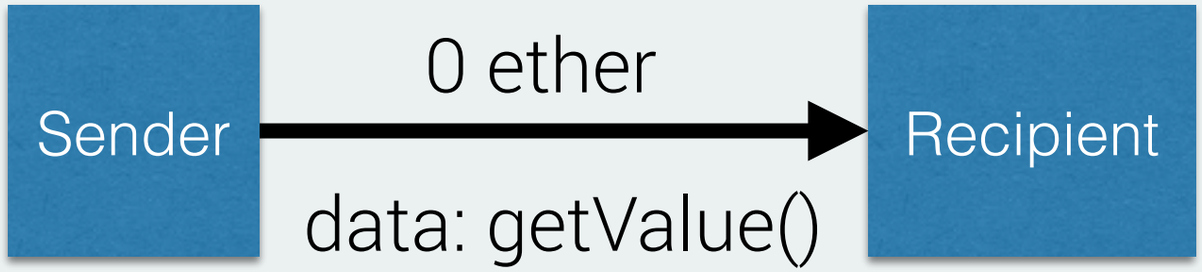
Blockchain

Message

1 Sender

1 Recipient



Value in Ether / Wei (can be 0)

Can have additional data (for function calls)

Can have return value

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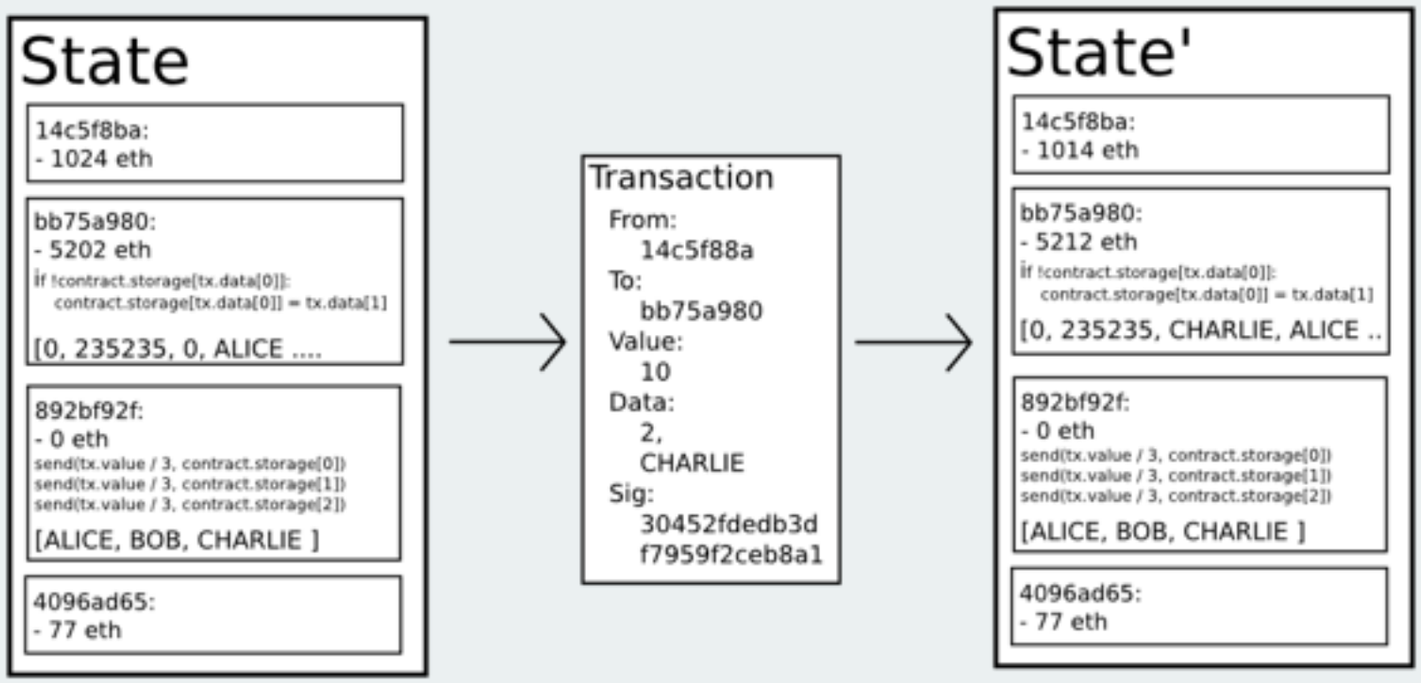
Blockchain

Transaction

Contains a message

Signed by a private key (external account)

Transitions from one state to the next



Blockchain

Gas

Used for transaction fees

Sender “buys” gas at a sender-specified **gasprice**

Every computational step has a fixed gas cost

Remaining gas sent back to sender

If gas runs out

- the state reverts
- but miner keeps ether

Blockchain

Gasprice

Associated gas cost for some action is constant

But the price of ether is not

Gasprice is a scale factor against ether price

Ether goes up -> Gasprice goes down

Ether goes down -> Gasprice goes up

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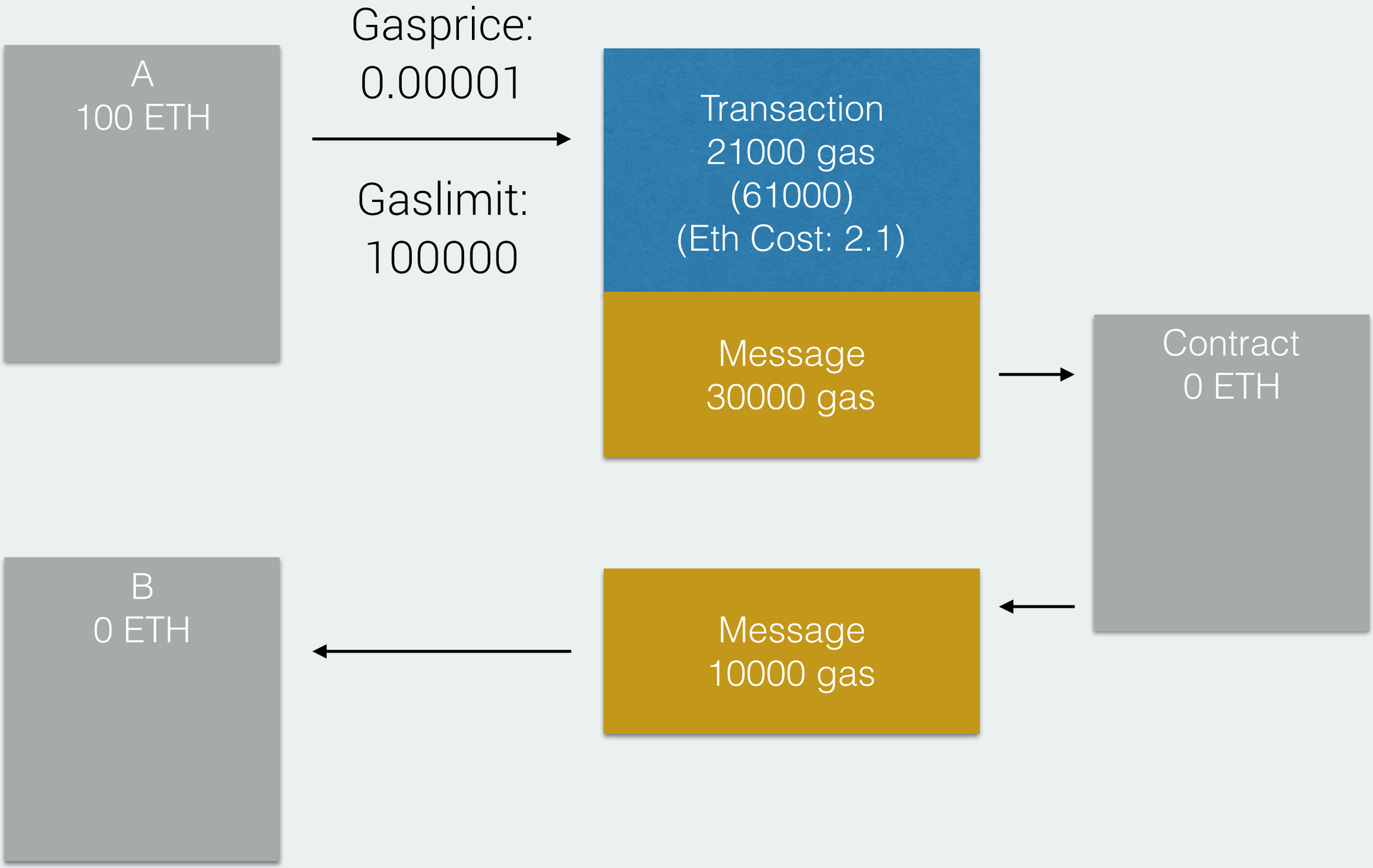
Blockchain



Blockchain

A
90 ETH

-10 ETH

Gasprice:
0.00001

Gaslimit:
100000

Transaction
21000 gas
(61000)
(Eth Cost: 2.1)

Message
30000 gas

Contract
0 ETH

B
0 ETH

Message
10000 gas

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Blockchain

A
89 ETH

-10 ETH
-1 ETH

Gasprice:
0.00001

Gaslimit:
100000

Transaction
21000 gas
(61000)
(Eth Cost: 2.1)

Message
30000 gas

Contract
0 ETH

Gas: 100000

B
0 ETH

Message
10000 gas

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Blockchain

A
89 ETH

-10 ETH
-1 ETH

Gasprice:
0.00001

Gaslimit:
100000

Transaction
21000 gas
(61000)
(Eth Cost: 2.1)

Message
30000 gas

Gas: 39000
~ 0.39 ETH

Contract
0 ETH

+10 ETH
-10 ETH

B
10 ETH

+10 ETH

Message
10000 gas

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Blockchain

A
89.39 ETH

-10 ETH
-1 ETH
+0.39 ETH

Gasprice:
0.00001

Gaslimit:
100000

Transaction
21000 gas
(61000)
(Eth Cost: 2.1)

Message
30000 gas

Gas: 0
~ 0 ETH

Contract
0 ETH

+10 ETH
-10 ETH

B
10 ETH

+10 ETH

Message
10000 gas

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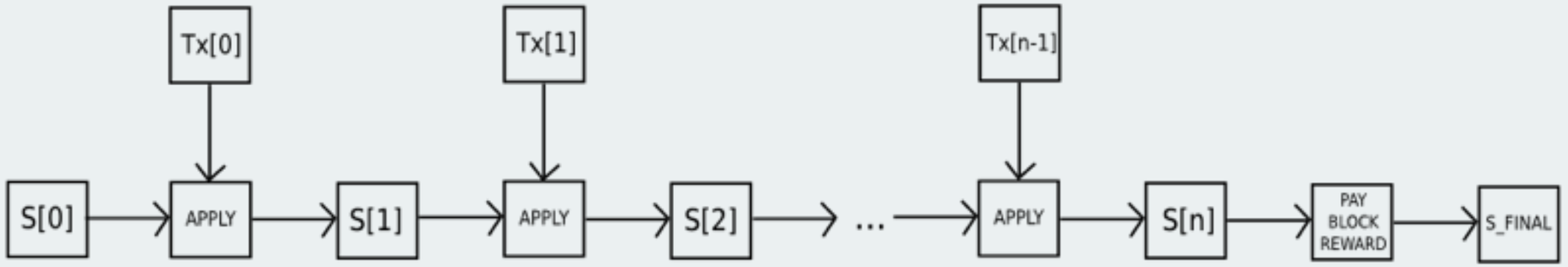
Blockchain

Blockchain gives transactions an order

Transactions are grouped together into blocks



Order is important:

Double spend (no unspent outputs, but balance might become 0)

2 transactions interacting with the same contract

Different order -> Potential different outcome

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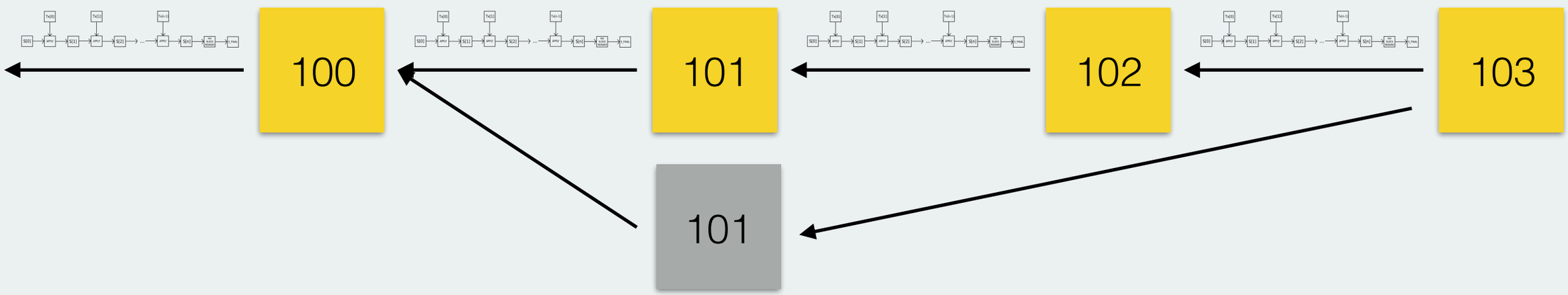
Blockchain

Blocks form a chain

~15 seconds apart

Some can uncle blocks



Longest chain is considered the consensus

Blockchain

Proof of Work (Ethereum 1.0)

EthHash

asic-resistant (high memory, io bandwidth)

targets gpu mining (2GB+ GRAM)

To be succeeded by Casper (PoS)

Exponential difficulty increase -> Freeze in December (?)

Constant Block Reward during PoW Phase

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Blockchain

Yellow Paper (github: ethereum/latexpaper)

ETHEREUM: A SECURE DECENTRALISED GENERALISED TRANSACTION LEDGER

HOMESTEAD DRAFT

0xf1 CALL 7 1 Message-call into an account.

$$\mathbf{i} \equiv \boldsymbol{\mu}_\mathbf{m}[\boldsymbol{\mu}_\mathbf{s}[3] \dots (\boldsymbol{\mu}_\mathbf{s}[3] + \boldsymbol{\mu}_\mathbf{s}[4] - 1)]$$

$$(\boldsymbol{\sigma}', g', A^+, \mathbf{o}) \equiv \begin{cases} \Theta(\boldsymbol{\sigma}, I_a, I_o, t, t, & \text{if} \quad \boldsymbol{\mu}_\mathbf{s}[2] \leqslant \boldsymbol{\sigma}[I_a]_b \wedge \\ \quad C_{\text{CALLGAS}}(\boldsymbol{\mu}), I_p, \boldsymbol{\mu}_\mathbf{s}[2], \boldsymbol{\mu}_\mathbf{s}[2], \mathbf{i}, I_e + 1) & \quad I_e < 1024 \\ (\boldsymbol{\sigma}, g, \varnothing, \mathbf{o}) & \text{otherwise} \end{cases}$$

$$n \equiv \min(\{\boldsymbol{\mu}_\mathbf{s}[6], |\mathbf{o}|\})$$

$$\boldsymbol{\mu}'_\mathbf{m}[\boldsymbol{\mu}_\mathbf{s}[5] \dots (\boldsymbol{\mu}_\mathbf{s}[5] + n - 1)] = \mathbf{o}[0 \dots (n-1)]$$

$$\boldsymbol{\mu}'_g \equiv \boldsymbol{\mu}_g + g'$$

$$\boldsymbol{\mu}'_\mathbf{s}[0] \equiv x$$

$$A' \equiv A \Cup A^+$$

$$t \equiv \boldsymbol{\mu}_\mathbf{s}[1] \mod 2^{160}$$

where $x = 0$ if the code execution for this operation failed due to an exceptional halting $Z(\boldsymbol{\sigma}, \boldsymbol{\mu}, I) = \top$ or if $\boldsymbol{\mu}_\mathbf{s}[2] > \boldsymbol{\sigma}[I_a]_b$ (not enough funds) or $I_e = 1024$ (call depth limit reached); $x = 1$ otherwise.

$$\boldsymbol{\mu}'_i \equiv M(M(\boldsymbol{\mu}_i, \boldsymbol{\mu}_\mathbf{s}[3], \boldsymbol{\mu}_\mathbf{s}[4]), \boldsymbol{\mu}_\mathbf{s}[5], \boldsymbol{\mu}_\mathbf{s}[6])$$

Thus the operand order is: gas, to, value, in offset, in size, out offset, out size.

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Whisper / Swarm
Mist

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Whisper

Decentralised Messaging

Messages can be filtered by topics

Very flexible

- Messages can be encrypted
- Messages can be signed
- Broadcast

PoW for spam protection and priority

Not designed for real time communication

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Swarm

Swarm (or IPFS)

- Reverse Hash-table
- Originator of source unknown
- Low-latency
- Incentivation model for storage

merged into geth

Orange Papers

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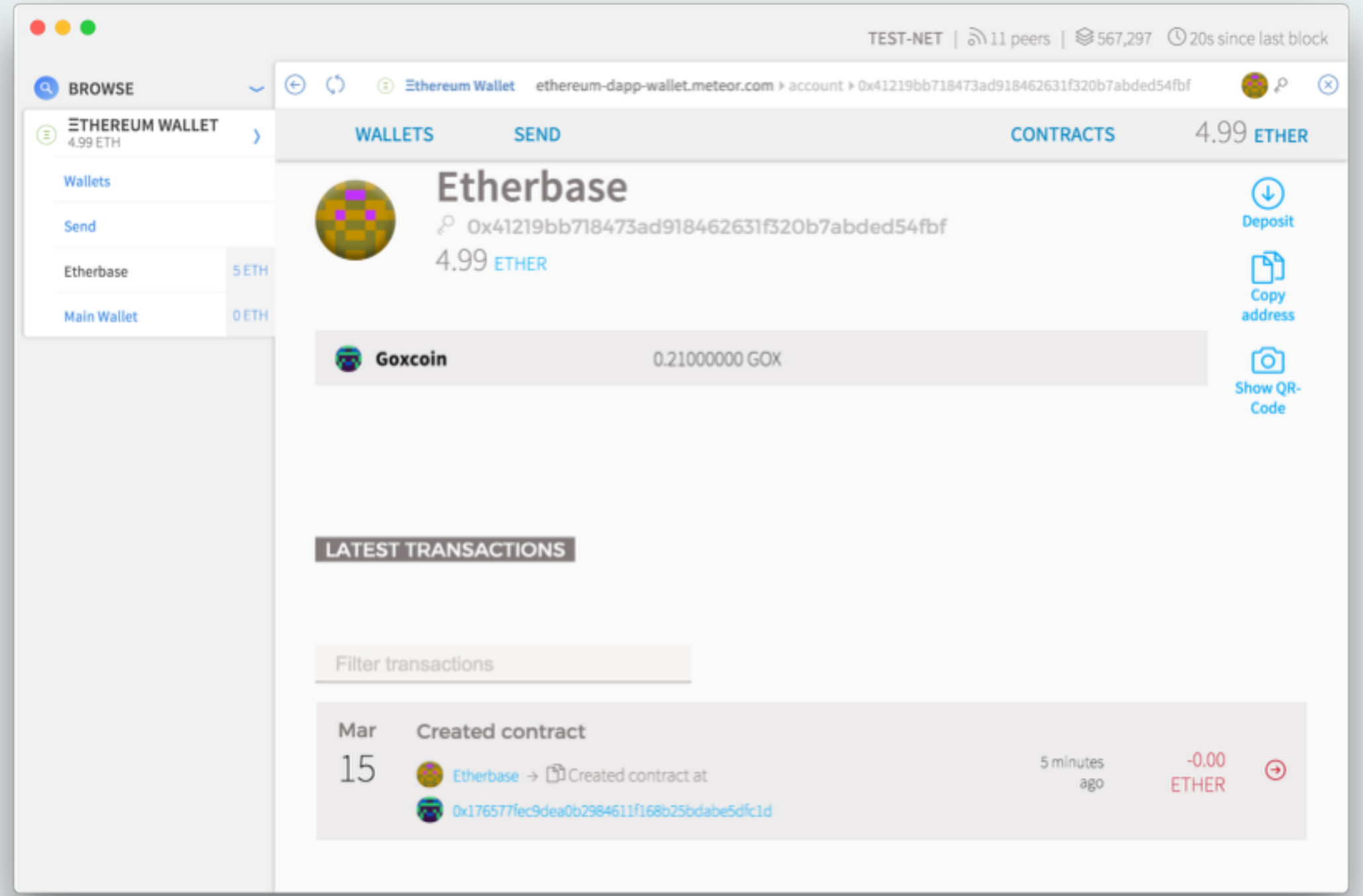
Mist



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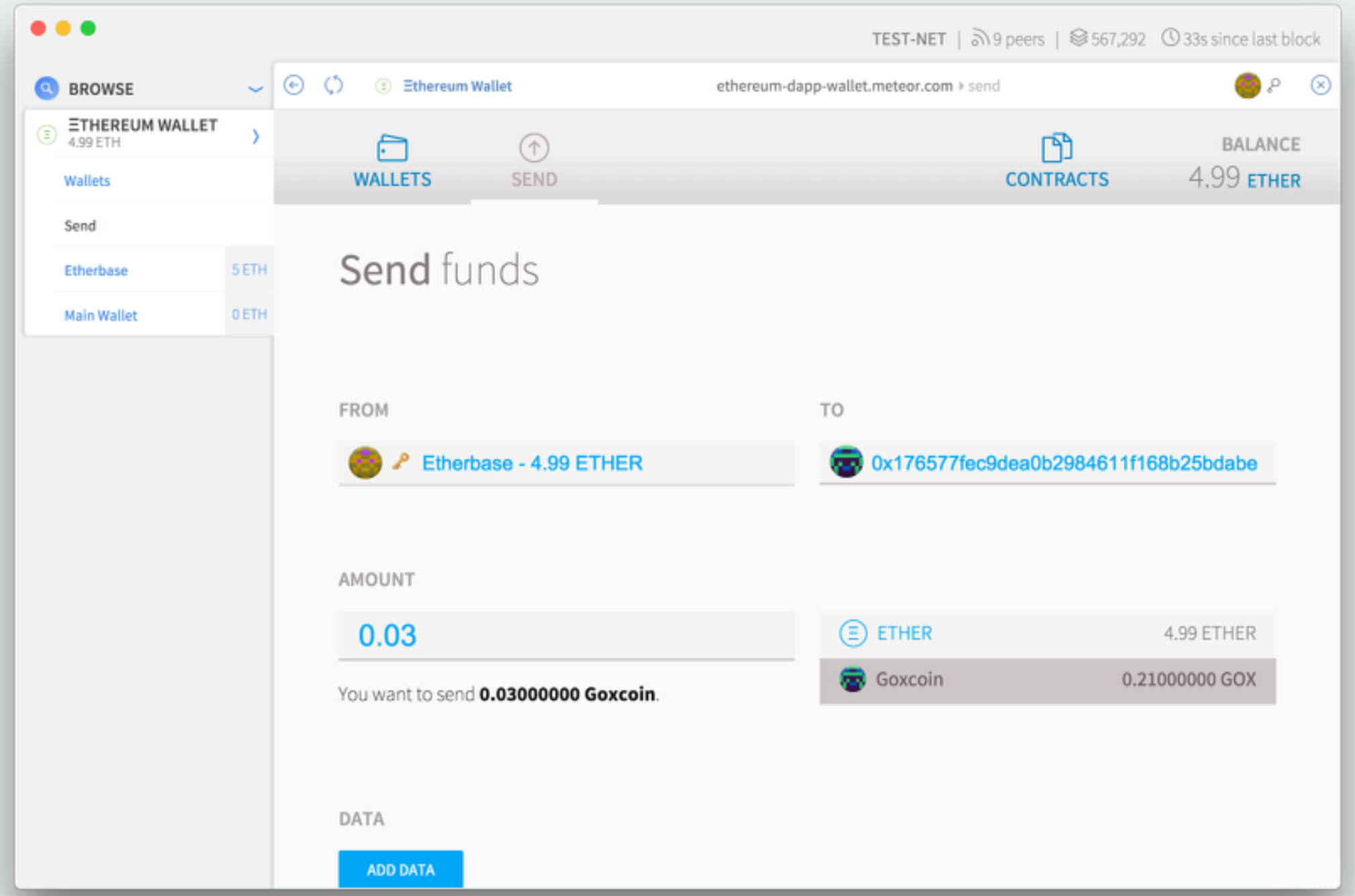
Mist



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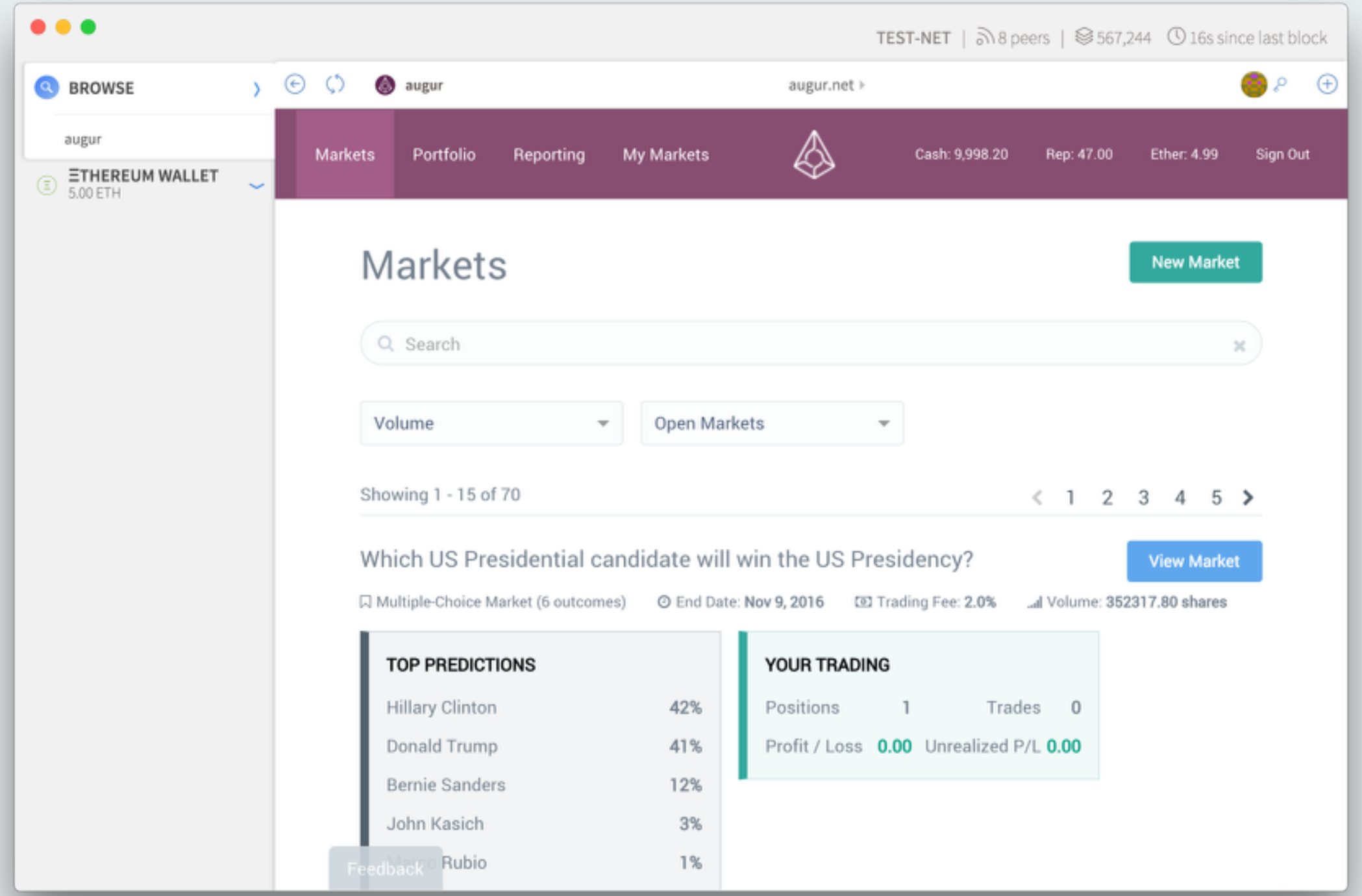
Mist



Marketplace DApp Example

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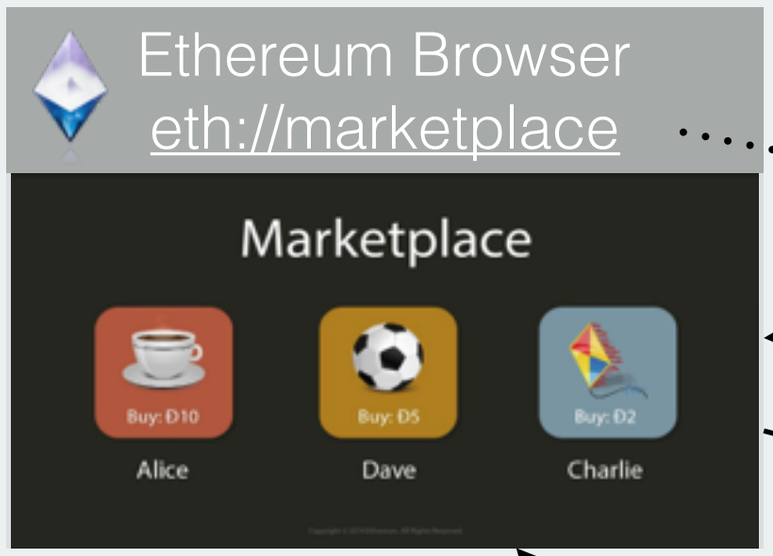
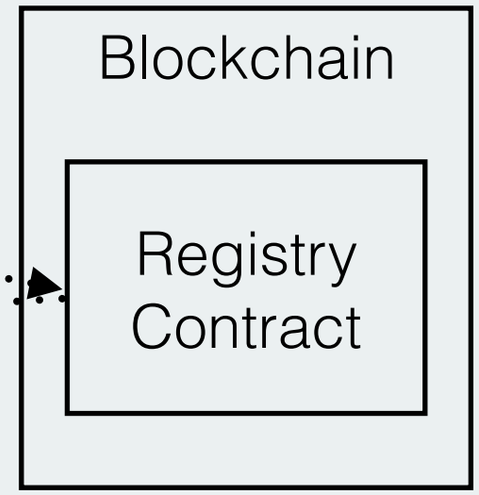
DApp

User enters URL



URL

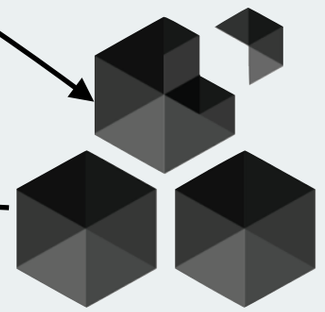
HASH



Registry translates URL to HASH

HASH

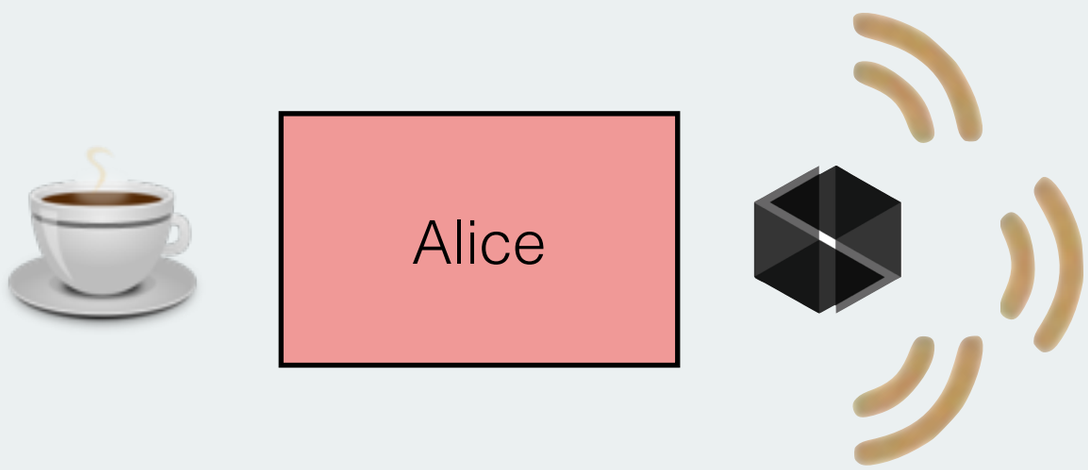
HTML
CSS
JSON



ethereum Marketplace

Alice wants to sell a cup for 10 ETH

Whisper Broadcast
"I want to sell a cup for 10 ETH"



Broadcasts a Whisper message

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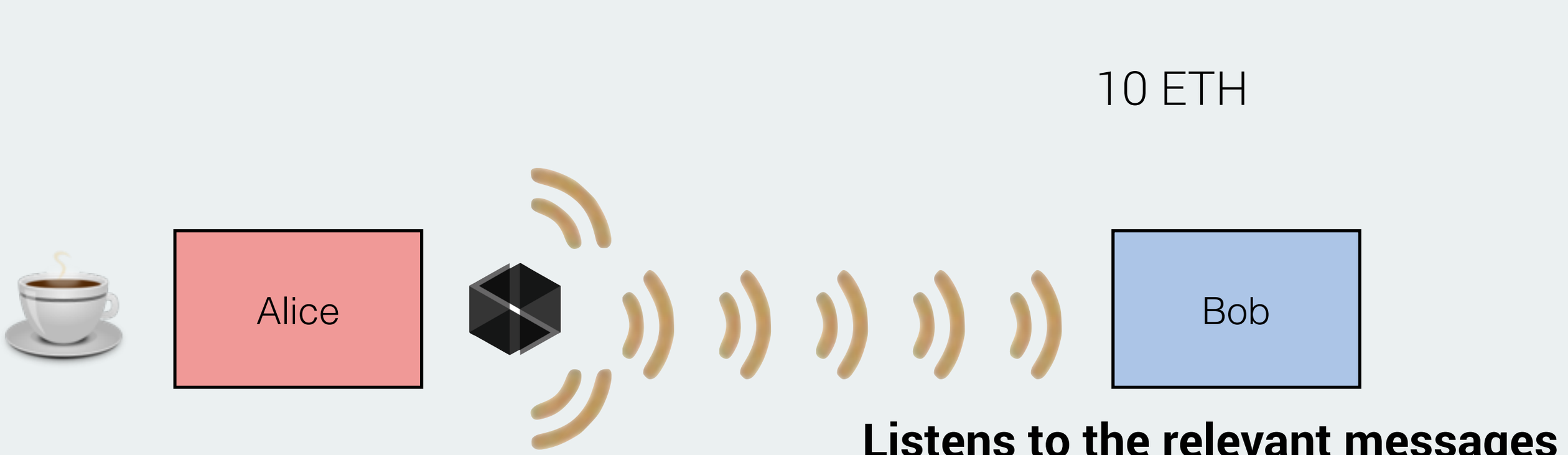
Bob wants to buy cups



Listens to the relevant messages

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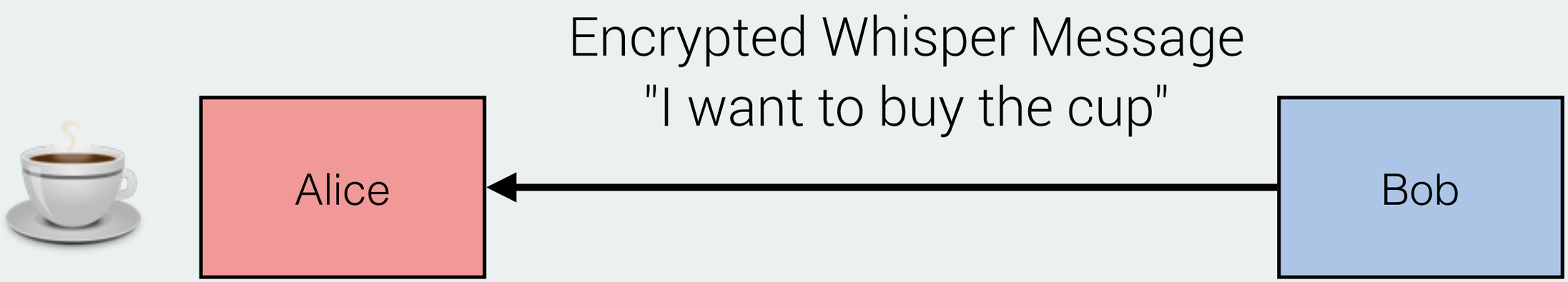
Bob sees Alice's offer and wants to buy



Sends a private message to Alice

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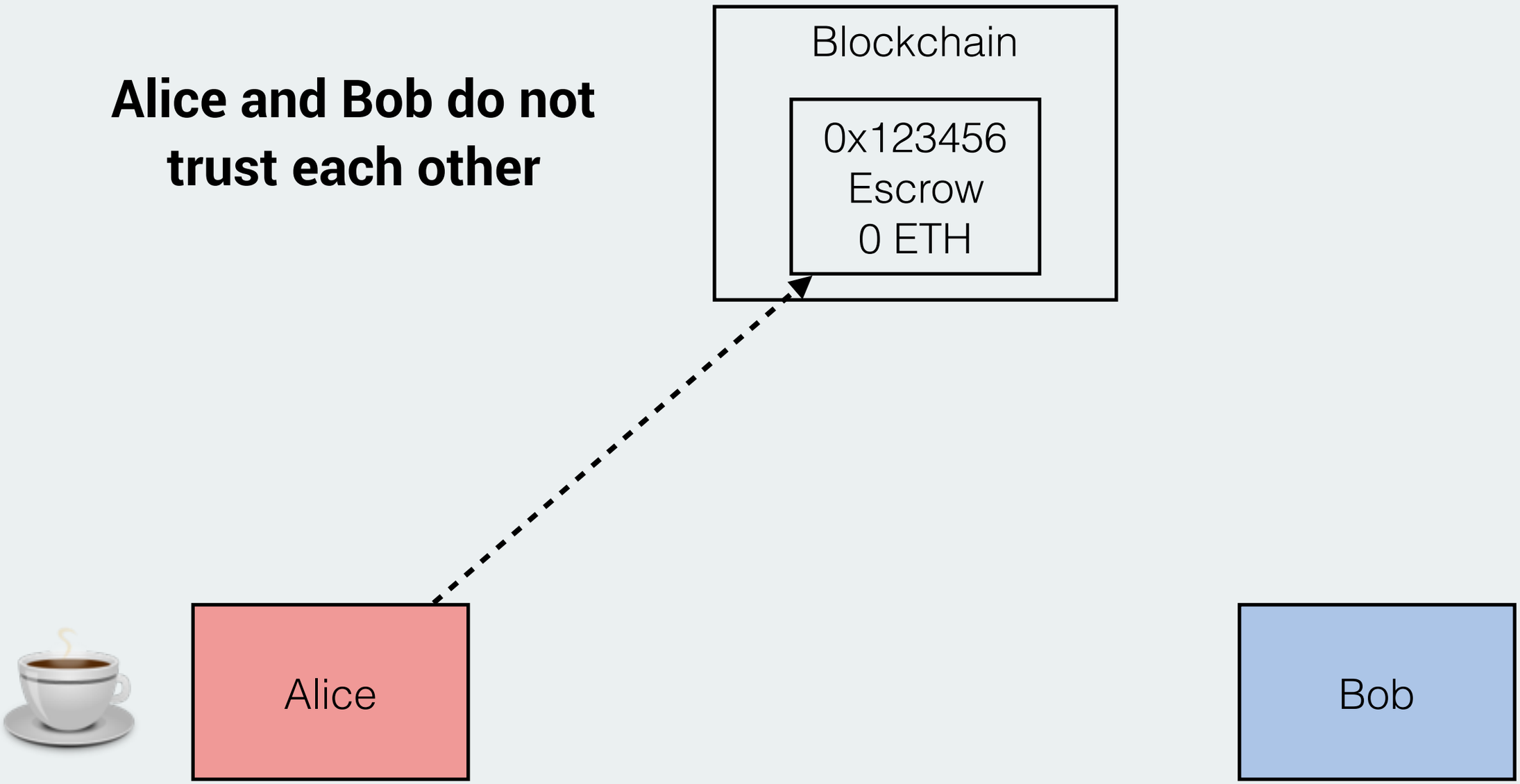
Alice and Bob do not trust each other



Alice creates an escrow contract

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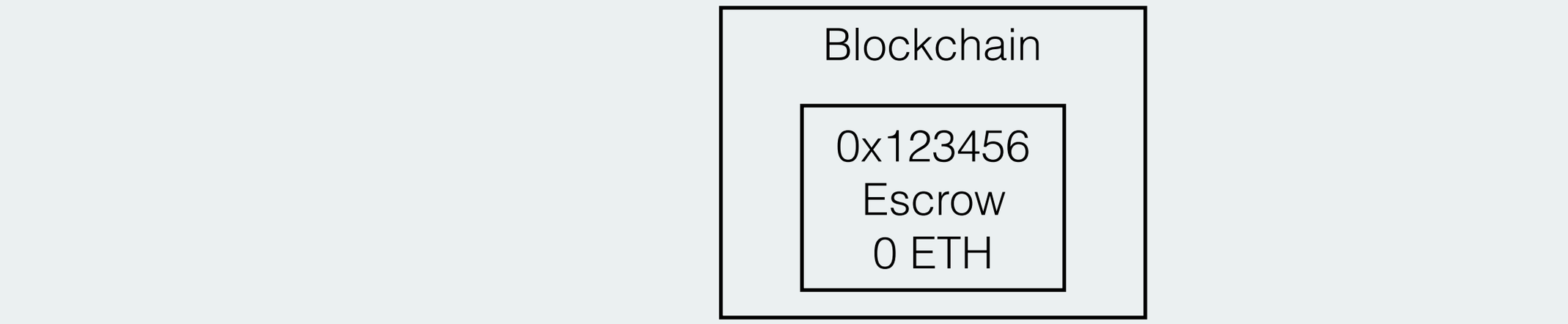

Alice informs Bob about the escrow

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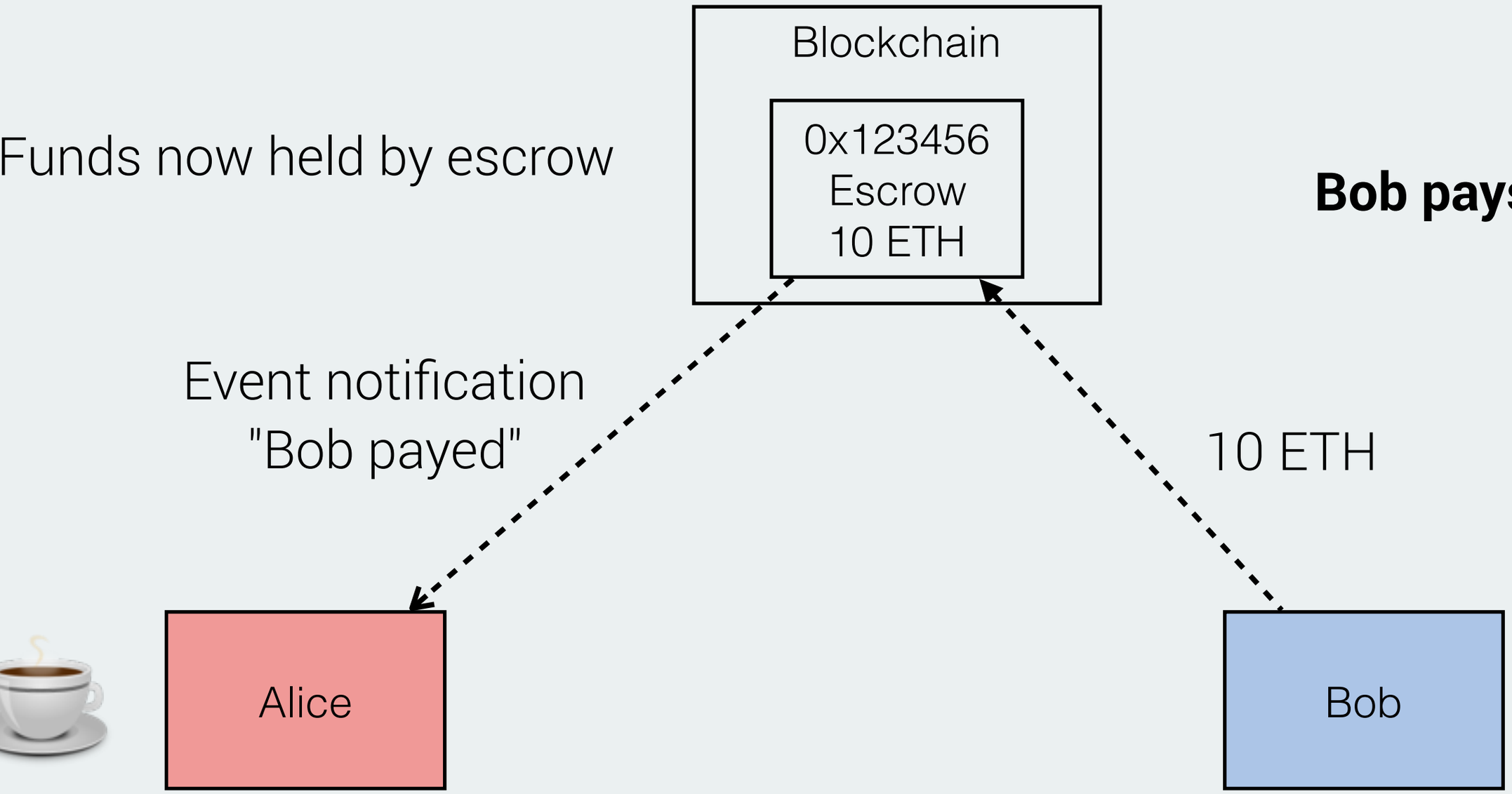
Funds now held by escrow



Bob pays

Alice watches the blockchain

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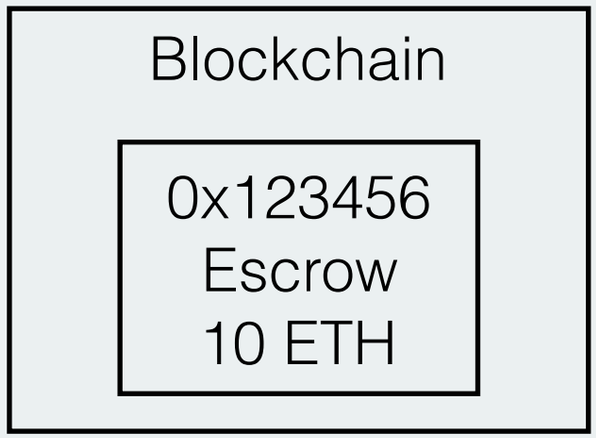

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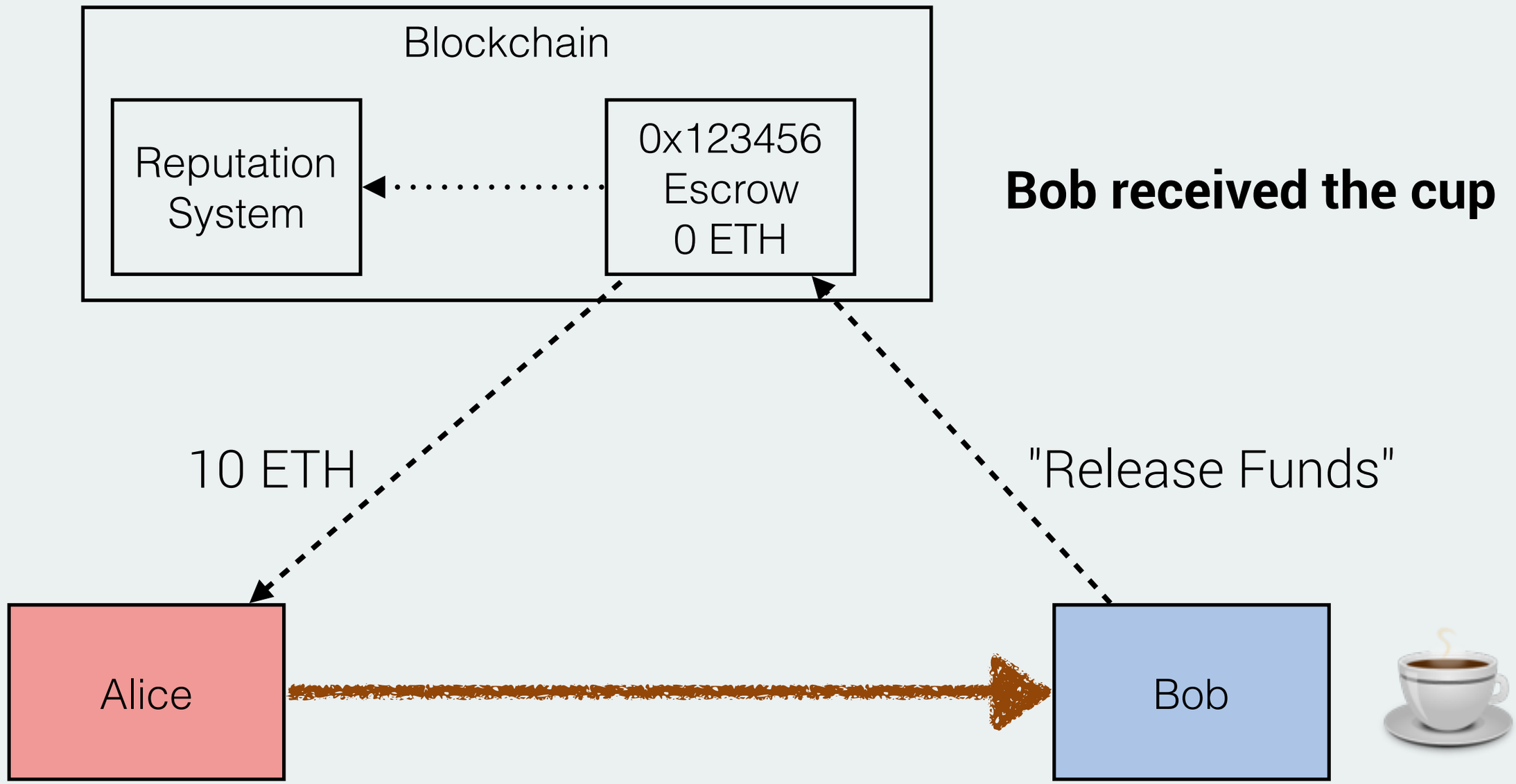

Bob received the cup

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Funding

Funded by crowdfunding

31.529 BTC raised (~18.5m USD at the time)

Over 9000 Transactions

half of that value lost due to bitcoin price decline

but rise in ether price secured funding for 4 years

2.0

- Abstraction
  - Contract pays fee
  - Other signing mechanisms
- Casper
  - Proof of Stake with weak subjectivity
  - Prediction market for blocks
- Scalability
  - Sharding

ethereum Release Process

OLYMPIC

Jul 2015

FRONTIER

Ethereum 1.0 chain

Kill Switches

Console client only

Hardfork
Now deemed safe

Mar 2016

HOMESTEAD

Ethereum 1.0 chain

UI Wallet

DAO HF

Q1 2017

METROPOLIS

Release of **Mist**
DApp Store
Full Light Client
Abstractions (Part I)

Hardfork

???

Casper
Sharding
Abstractions

SERENITY