SmartPool: Decentralized mining pools using smart contracts

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Outline

- What is mining & pooled mining
- Why centralized mining pool is not ideal
- SmartPool solution

What is mining

- Probabilistically elects leaders to propose blocks
  - By solving proof of work, or mining
- A way to issue more coins
  - 12.5 BTC per 1 Bitcoin block
  - 5 ETH per 1 Ethereum block

How to mine a block

- Need to find a nonce so that

$$\textit{Hash(BlockHeader, nonce)} \leq d$$

or

$$\textit{Hash(BlockHeader, nonce, dataset)} \leq d$$

- Finding a valid nonce is hard
  - Normal computers take years to find a valid nonce

Mining pool

- Group of miners join hand to mine blocks together
- Reward is split among miners based on their contributions
  - Reduce variance
  - Receive smaller rewards frequently

How mining pools work

- Pools track miner contributions by using shares
  - A share is similar to a block, but required less work to find

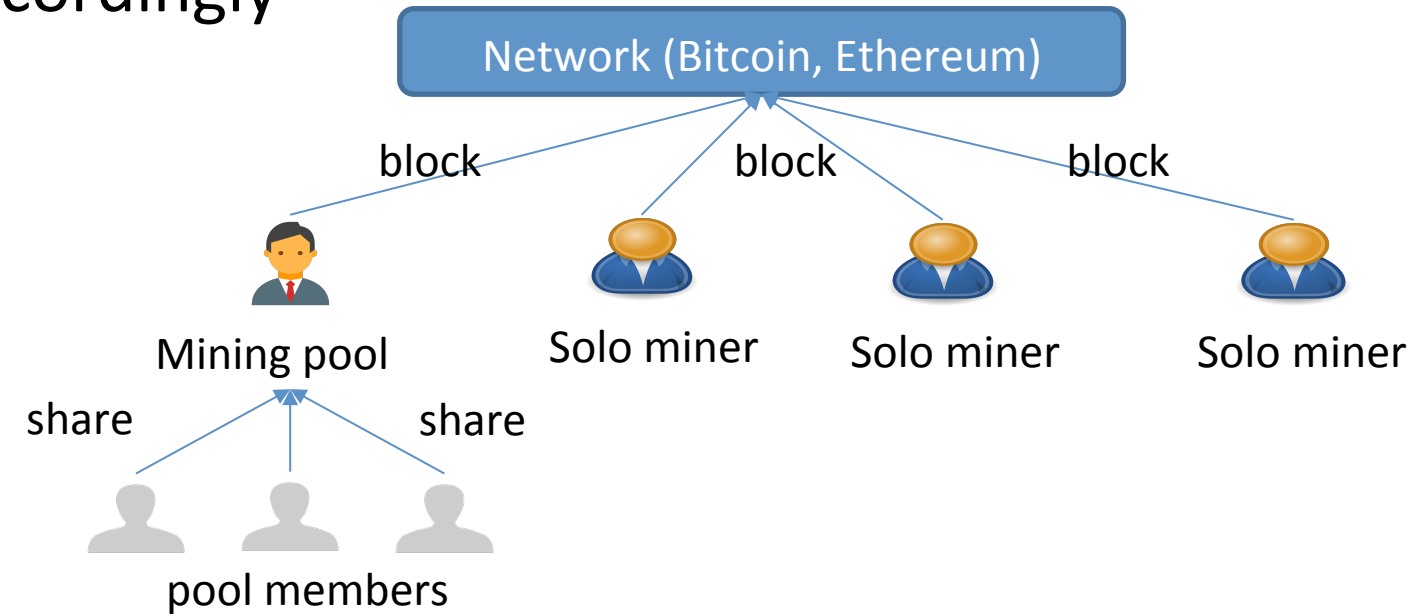
    Valid block ***Hash(BlockHeader, nonce, dataset) ≤ d***

    Valid share ***Hash(BlockHeader, nonce, dataset) ≤ D*** *with D >> d*

  - Each share has probability d/D being a valid block

How mining pools work (2)

- Pool operator records the shares, and distributes reward accordingly

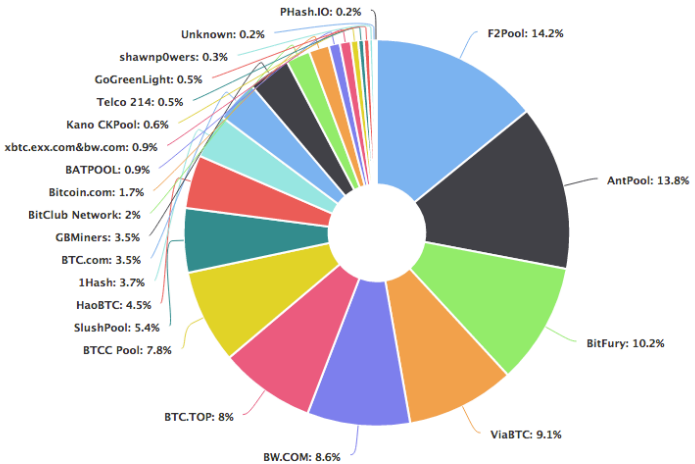


Pooled mining is great

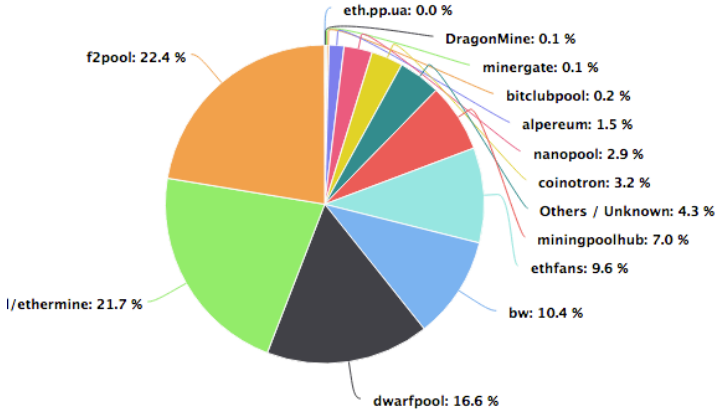
- For miners
  - Allow them to have stable income
  - Low variance means easier to make economic plan
- For the network
  - Help increase the security of the network by allowing more miners to join the mining process

Centralized pooled mining issues

- Mining in cryptocurrencies is highly centralized
  - 3-5 pools control majority of hash power



Bitcoin's mining power distribution



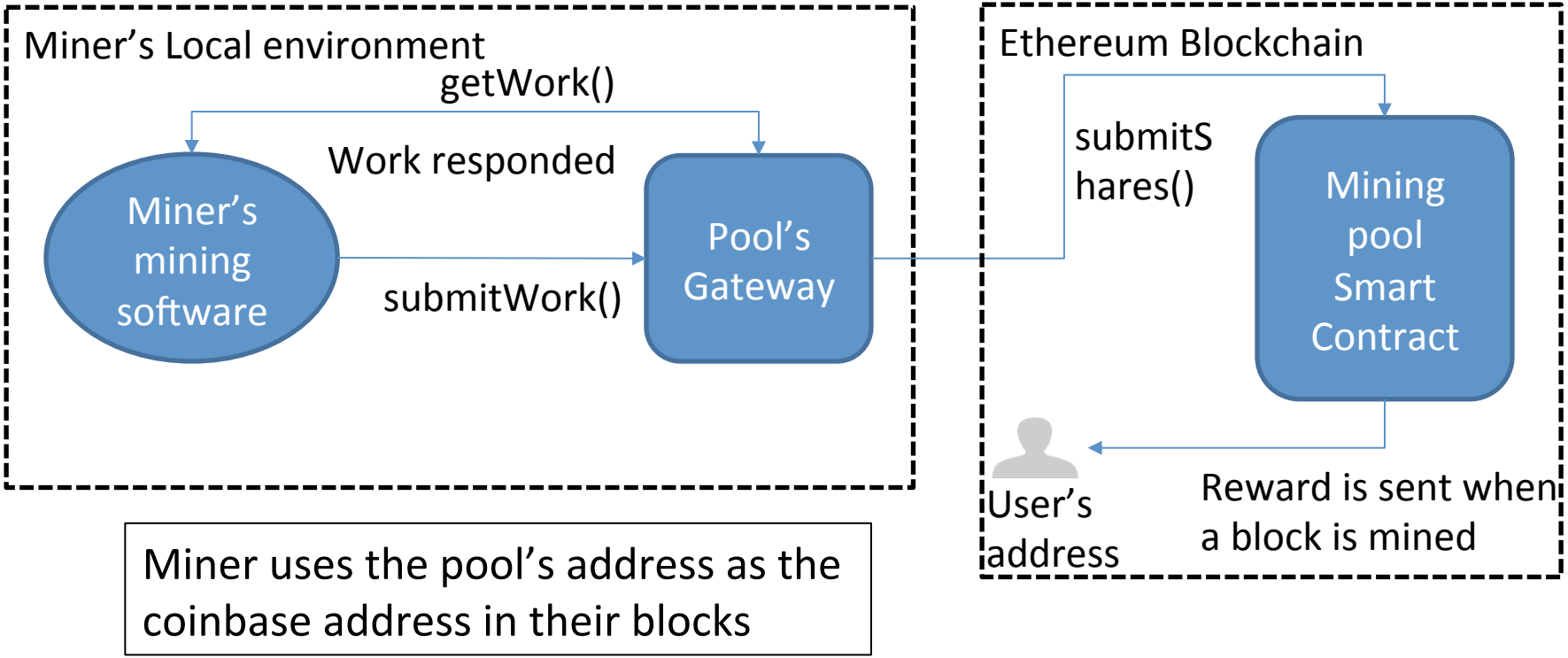
Ethereum's mining power distribution

Centralized pooled mining issues (2)

- Implicit trust
  - Miners trust pool to record shares and pay correctly
- Transaction censorship threat
  - Pools decide which transactions to include, not the miners
- Single point of failures
  - Easy to partition the network [IEEE SS&P '17]

SMARTPOOL: REPLACING POOL OPERATOR BY A SMART CONTRACT

Naïve solution



Miner uses the pool's address as the coinbase address in their blocks

Naïve solution's Problems

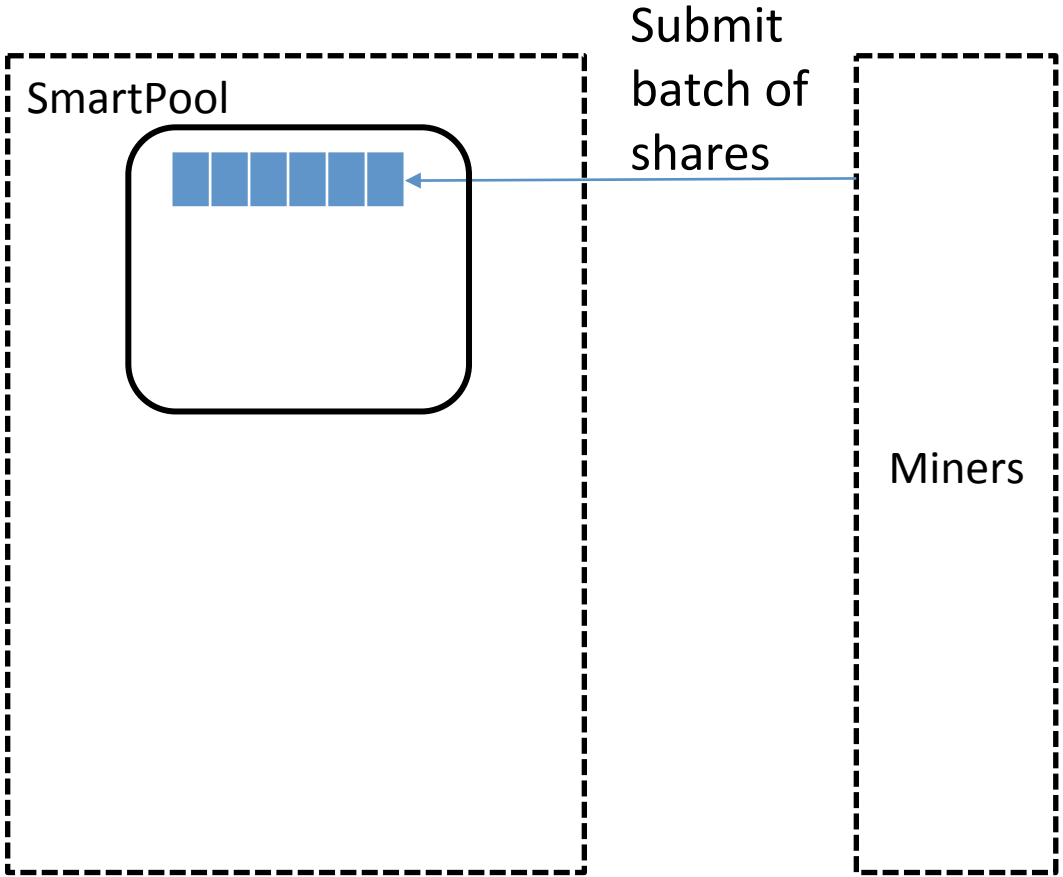
- Number of shares is large
  - May require billions of shares per block
  - Require as many messages to the contract
- Cost (gas) to verify a Ethash PoW is expensive
  - May be more than the reward per share
  - Render negative incomes to miners
- Verifying an Ethash PoW was not even technically feasible
  - Require access to 1GB data set
  - Smart contract storage is costly (around $80,000 USD per GB)

Hash(BlockHeader, nonce, dataset) ≤ d

SMARTPOOL’S SOLUTION

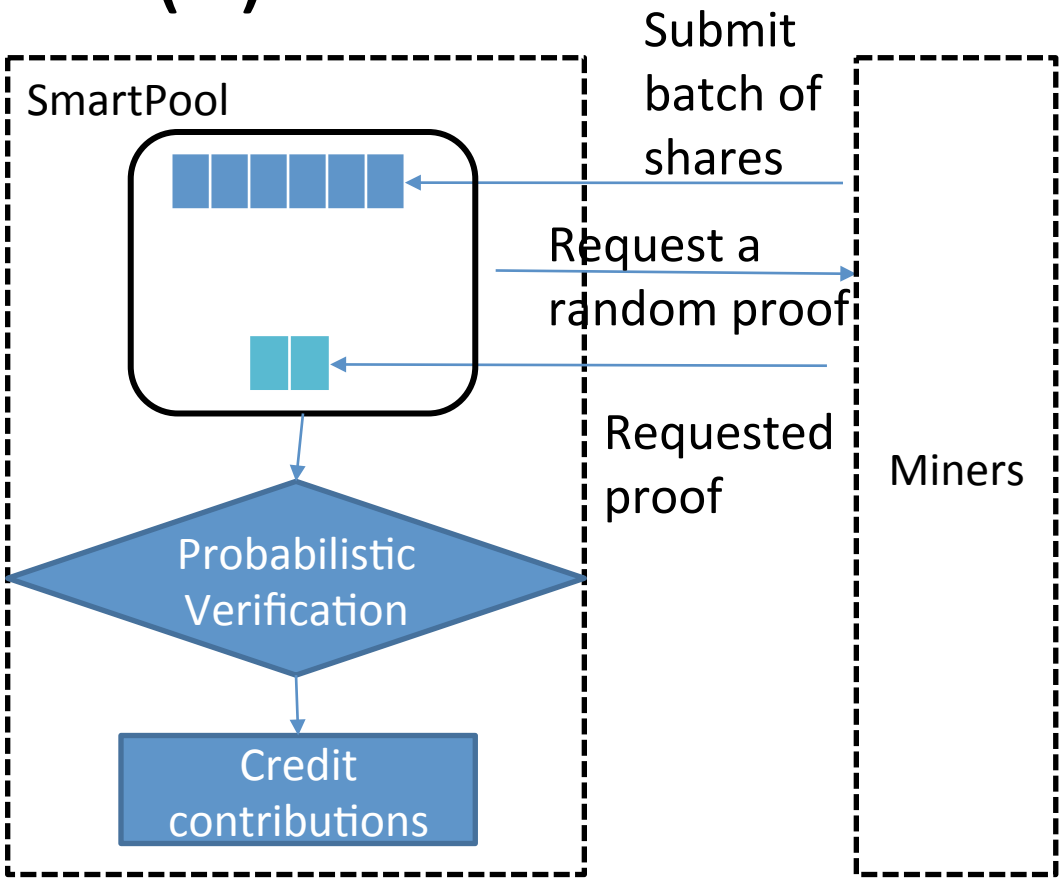
SmartPool – Solution

- Allow batch submissions (up to millions of shares)
  - significantly reduce number of transactions to the contract
  - only submit the Merkle root of all the shares



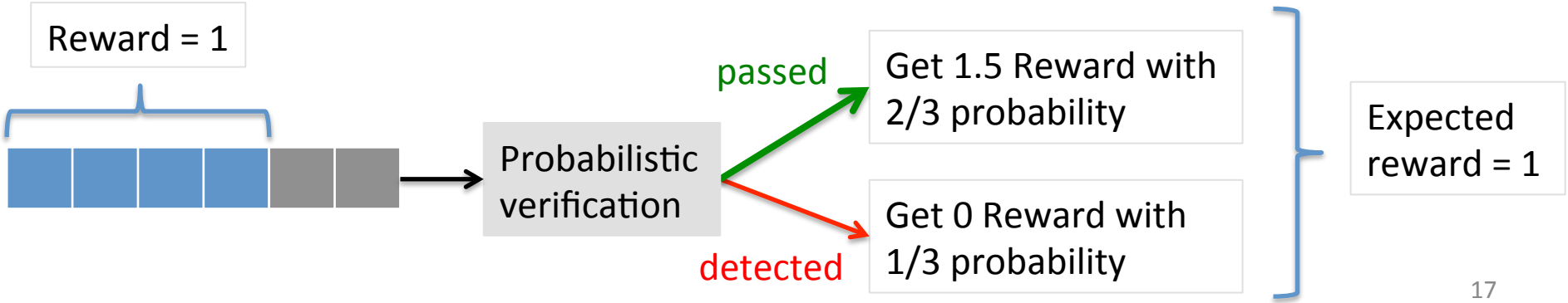
SmartPool – Solution (2)

- Probabilistic verification to check a submission
  - Randomly verify only one share per submission
  - Pr[of cheating detected] is proportional to the amount of cheating



SmartPool: Disincentivize cheating

- Penalty scheme: pay 0 share in a submission if cheating detected
  - Expected reward is the same whether cheating or not
  - Miners have no incentive to cheat
- If we sample more than 1 share, can strongly disincentivize cheating miners
- Cryptoeconomic is powerful!



SmartPool: Cheaply Verify Ethash PoW

- Verifying Ethash PoW was thought to be impossible inside a contract
  - ***dataset*** includes 64 random elements from a 1GB dataset. We can't store the entire 1GB dataset
  - Can we store just the 16MB dataset? Since the 1GB dataset is generated from the 16 MB one
    - Would cost hundreds of Ethers
    - The 16MB dataset changes every 30k blocks (4-5 days)
    - Getting the element in the 1Gb dataset from the 16MB seed is expensive
      - i.e. requires 8 SHA-512 computations per element, will run out of gas

Hash(BlockHeader, nonce, dataset) ≤ d

Our solution: only verify the result of Ethash

- Observation
  - We do not need the entire 1GB data set nor the 16Mb seed, we only care about the correctness of the 64 sampled elements (based on the nonce and the block header)
- Solution
  - Store the Merkle root of the 1GB dataset in the contract
    - Everyone can verify this Merkle root
  - Require the miners to send the merkle proof for each data element
    - Checking the proofs for 64 elements is much cheaper and simpler

SmartPool's Ethash in Testnet

- We self-implement the SHA-512 in solidity
  - Cost is 200k of gas per computation
- Fully verify an Ethash PoW with 3.9M of gas
  - Current gasLimit > 4M
  - Can be optmized further
- Our solution can be used to build a lighter light-client

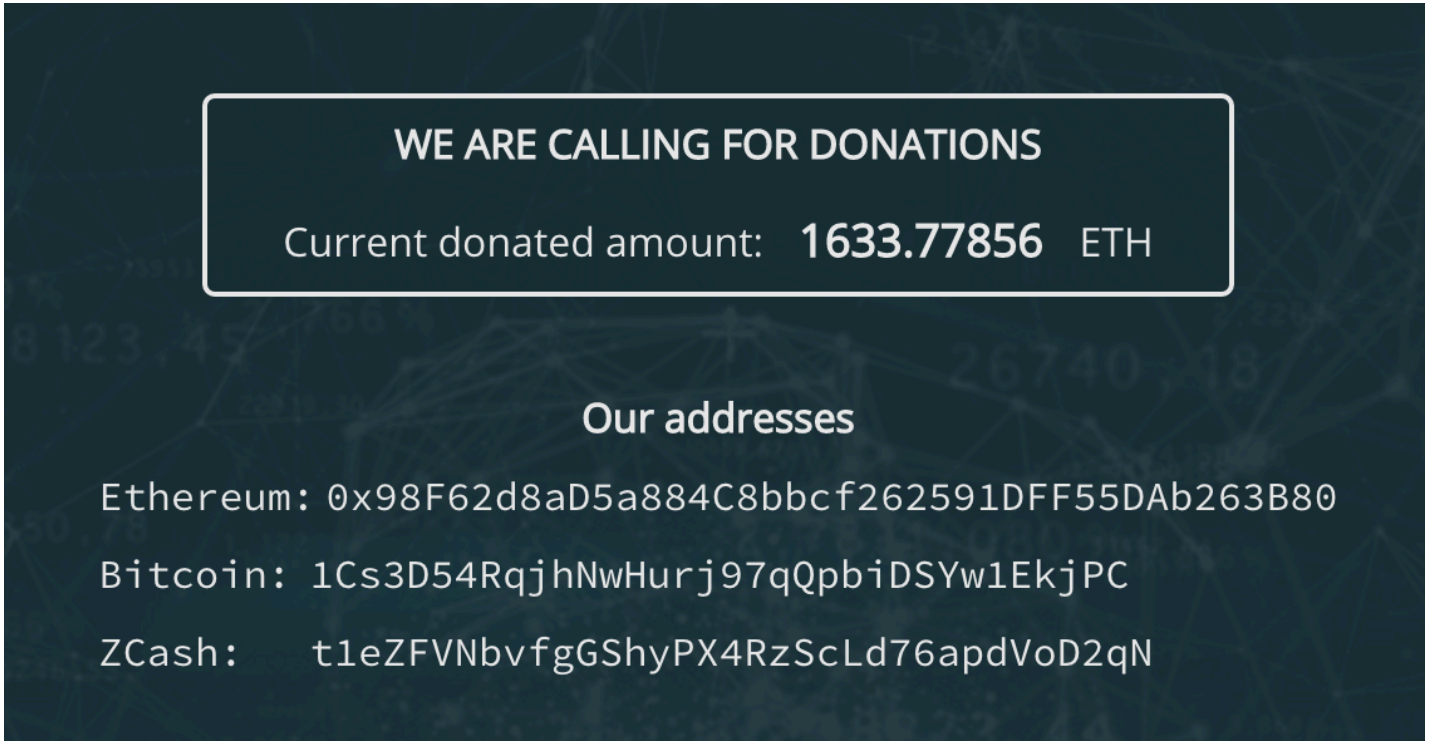
More in the white paper

- How to prevent miners from stealing others' shares?
- How to prevent claiming a share multiple times
  - Within a submission
  - Across submissions
- How to run mining pools for other cryptocurrencies on Ethereum

SmartPool: Features and Plan

- Features
  - Totally decentralized
  - Secure
  - Efficient and scalable
  - Open source and non-profit
- Plan
  - Testnet deployment in March
  - Mainnet deployment in May
  - Supporting other cryptocurrencies depends on funding

SmartPool.io is calling for donation



Closing thoughts

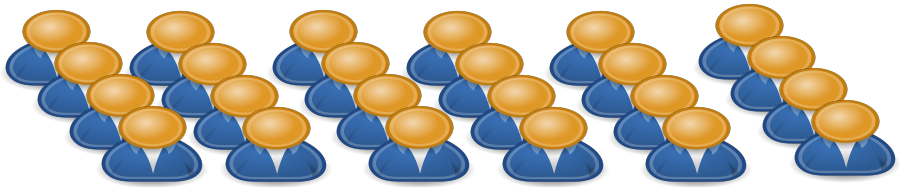
- Blockchains & smart contracts help remove middle man/ centralized operators
  - Decentralized mining pools is one example.
- Blockchains & smart contracts are the tools, not the solutions
  - More thoughts on the design and implementations required

Acknowledgement

- Ethereum Foundation

- DinarDirham

- 24 pseudonymous donors



Thank you – Q&A

http://smartpool.io

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