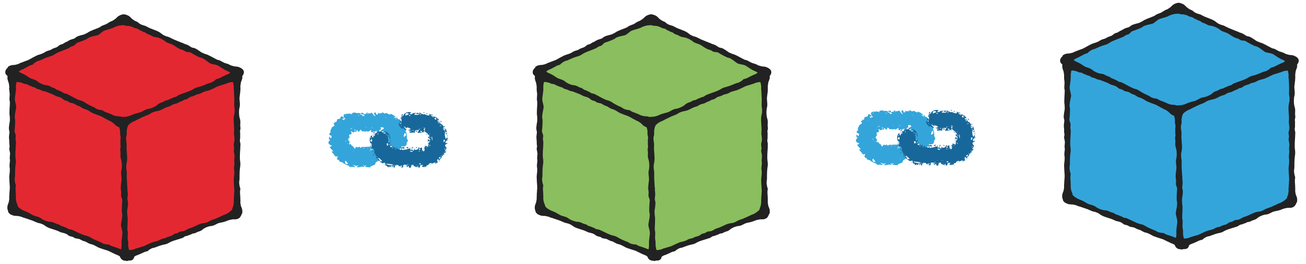

# Dissecting Bitcoin and Ethereum Transactions:
## On the Lack of Transaction Contention and Prioritization Transparency in Blockchains


Johnnatan Messias

@johnnatan_me

Joint w/ Vabuk Pahari, Balakrishnan Chandrasekaran, Krishna P. Gummadi, and Patrick Loiseau



Financial Cryptography and Data Security 2023



MAX PLANCK INSTITUTE FOR SOFTWARE SYSTEMS

UNIVERSITÄT DES SAARLANDES

VU VRIJE UNIVERSITEIT AMSTERDAM

Inria

UGA Université Grenoble Alpes

# 50+ BLOCKCHAIN
# REAL WORLD USES CASES

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uport

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ripple

### INSURANCE
A smart contract-based blockchain is being used by Insurer **American International Group Inc** as a means of saving costs and increasing transparency.

AIG

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IBM Walmart

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DIGITAL CURRENCY GROUP

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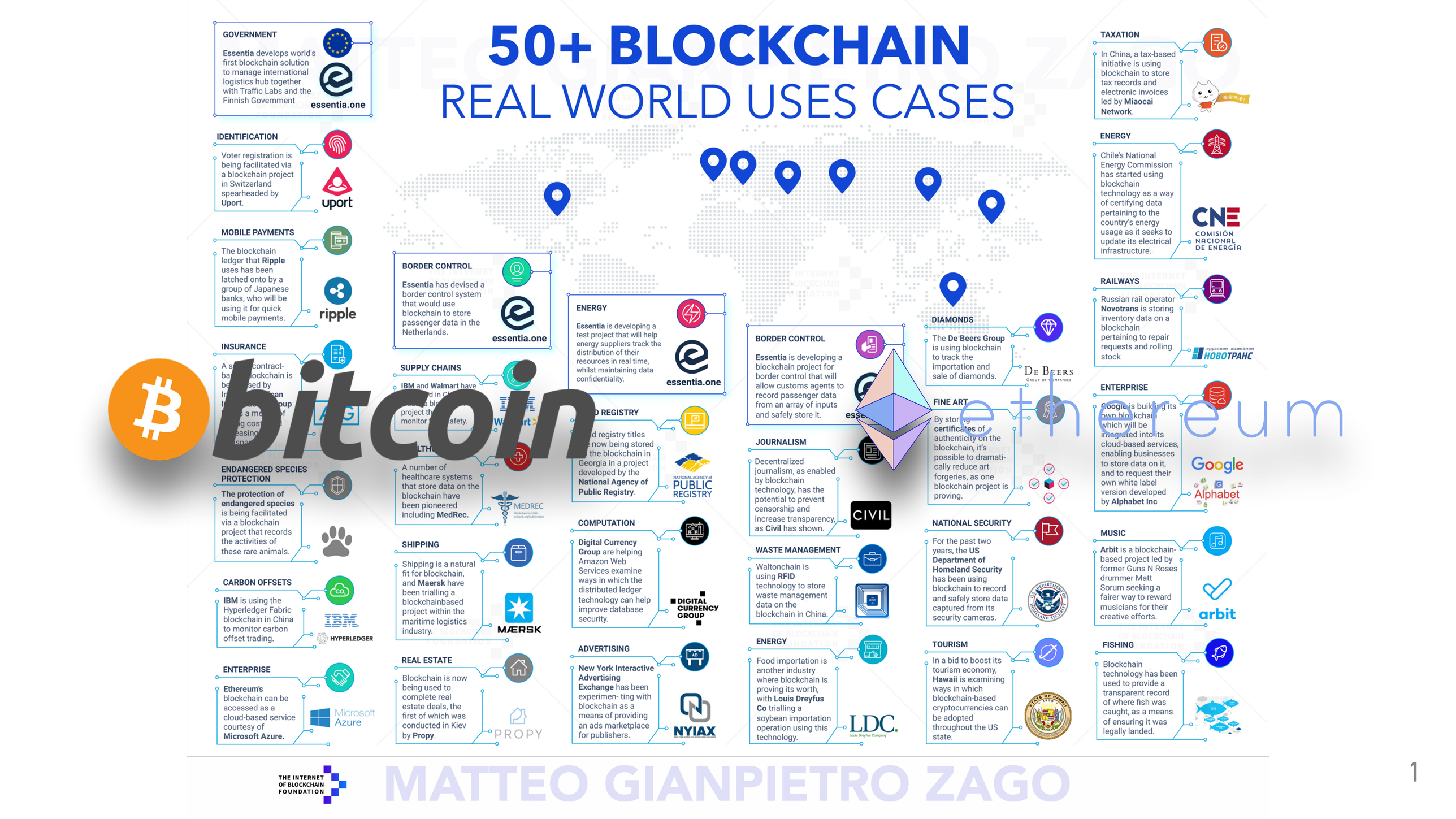

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# Lack of Transparency

**Public transactions**

10 30 5

$Tx_1$ $Tx_2$ $Tx_3$

50 1 15

$Tx_4$ $Tx_5$ $Tx_6$

**Miners**

Maria

50 30 15

$Tx_4$ $Tx_2$ $Tx_6$

10 5 1

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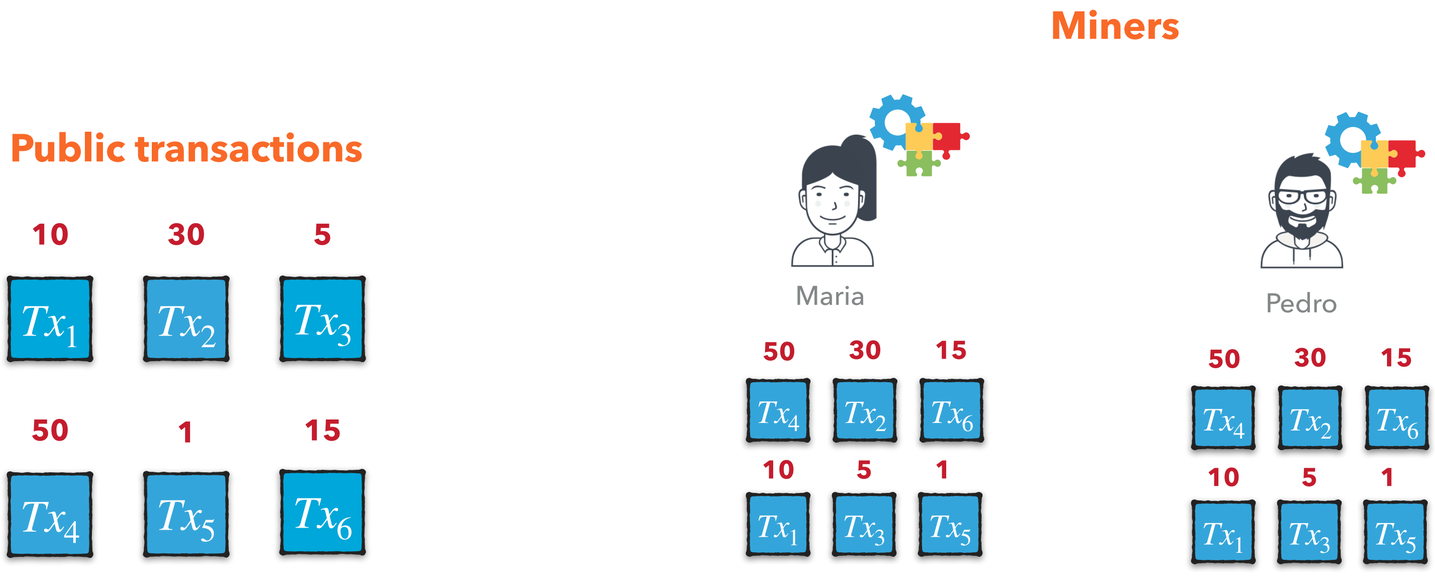

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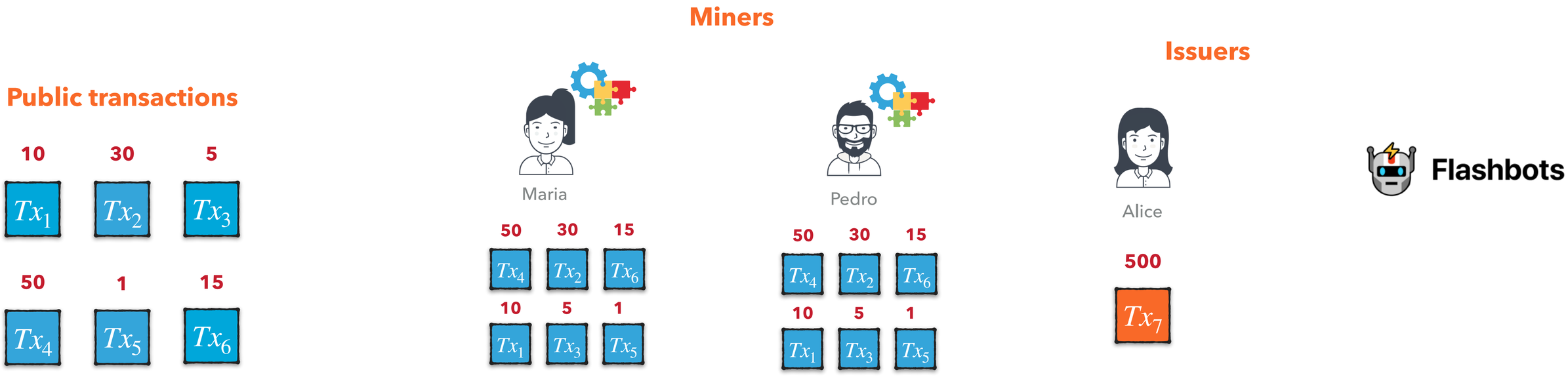

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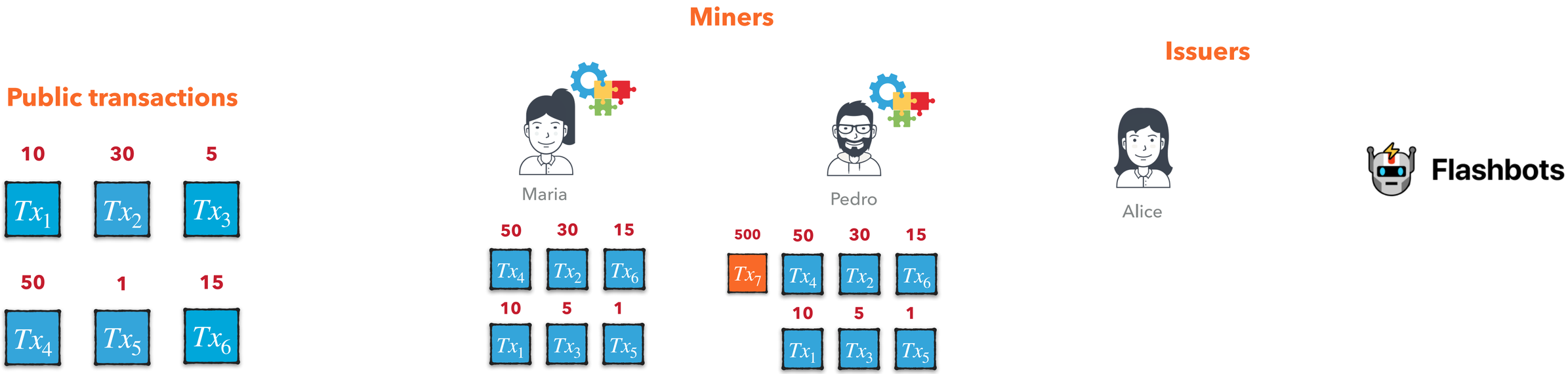

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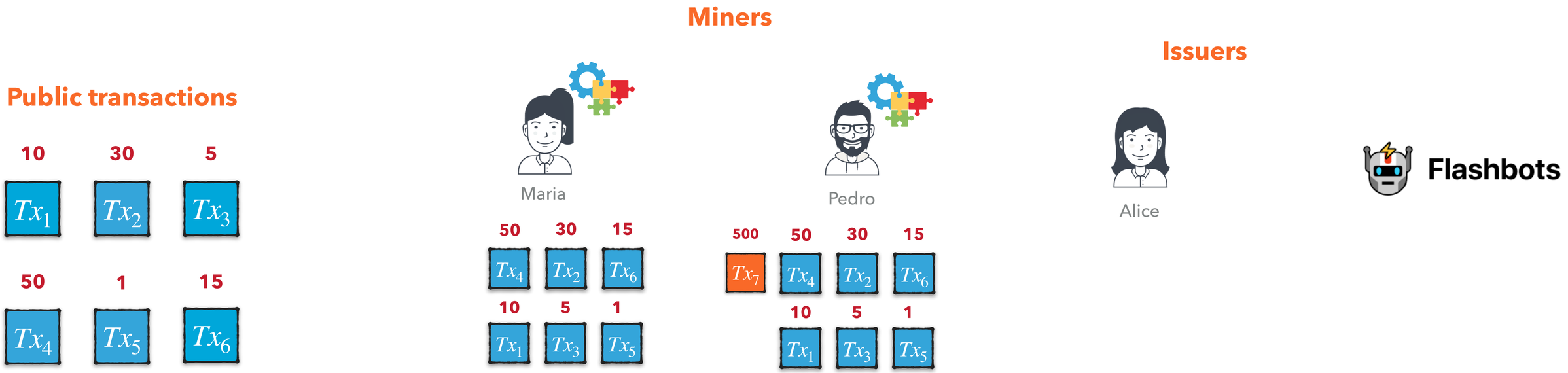

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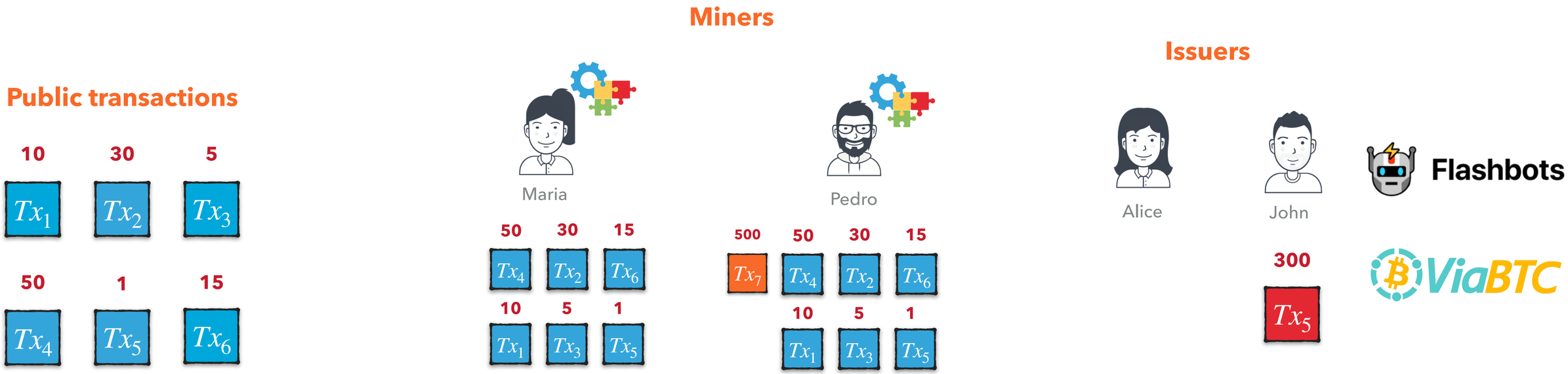

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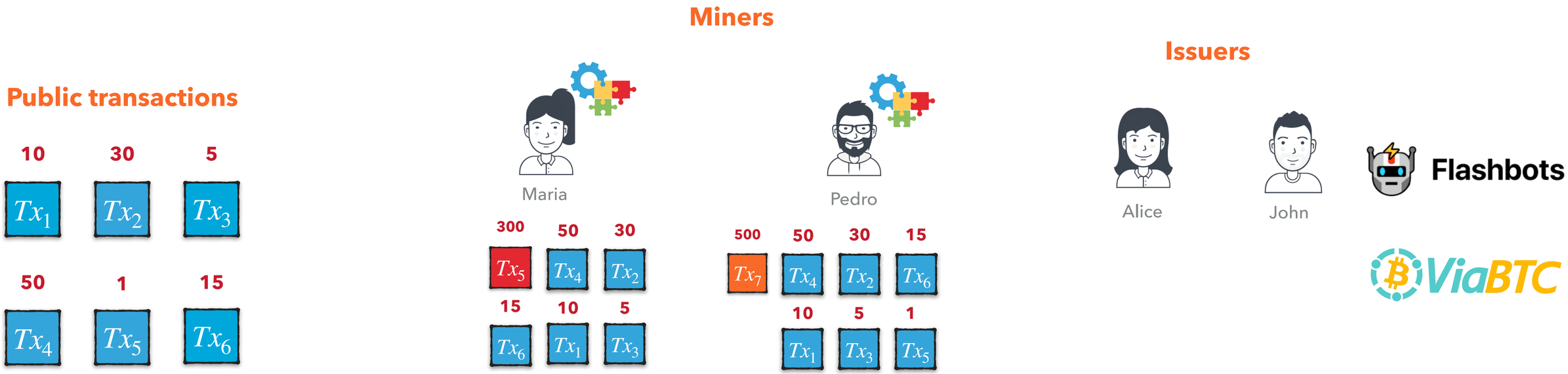

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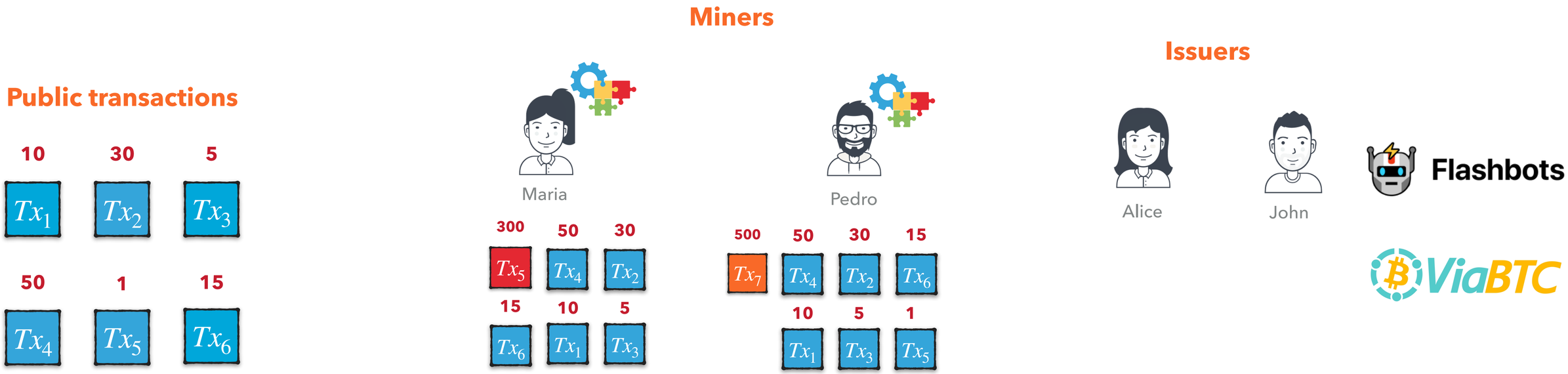

# Private Relay Networks:  Flashbots

- Users can bundle their transactions and send them privately to miners.
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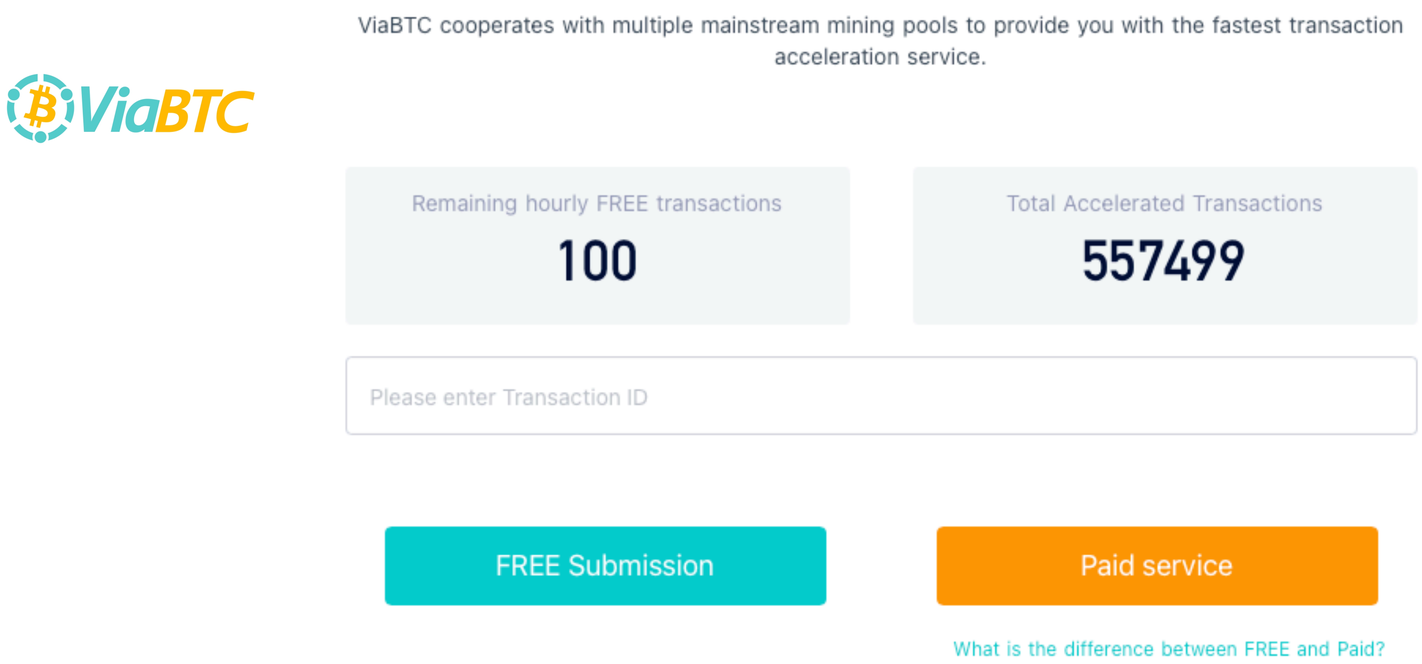
- Miners “promise" to include bundles on the top of their blocks.
  - In case of competition: Miner includes the bundle with higher incentive.
  - The other bundle with all its transactions is discarded as it has never existed.

# Private Relay Networks: Taichi Network

SPARK POOL

- Users can send their transactions privately to SparkPool and its patterns.
- Free to use.
- **No longer working.**

# Bitcoin Transaction Accelerators



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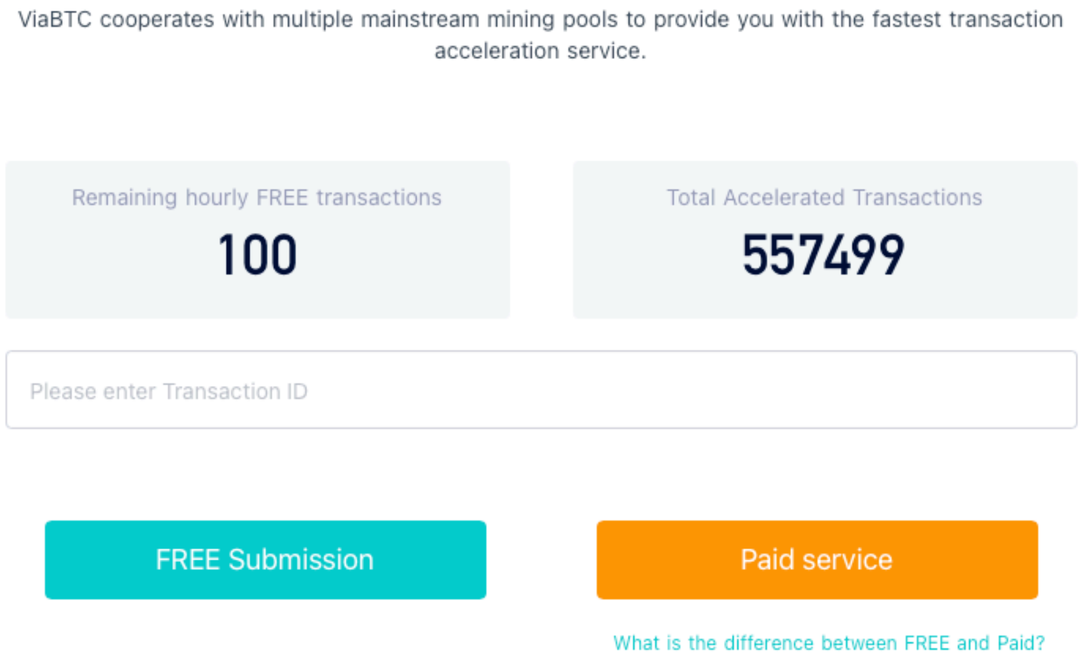


ViaBTC

BTC.com

f2pool

Poolin

bitcoin jumper

**Among others**

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ViaBTC

ViaBTC cooperates with multiple mainstream mining pools to provide you with the fastest transaction acceleration service.

Remaining hourly FREE transactions
100

Total Accelerated Transactions
557499

Please enter Transaction ID

FREE Submission

Paid service

What is the difference between FREE and Paid?

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Among others

✓ Available ✗ Unavailable

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| Block number | 501,951 to 663,904 | 13,183,000 to 15,049,999 |
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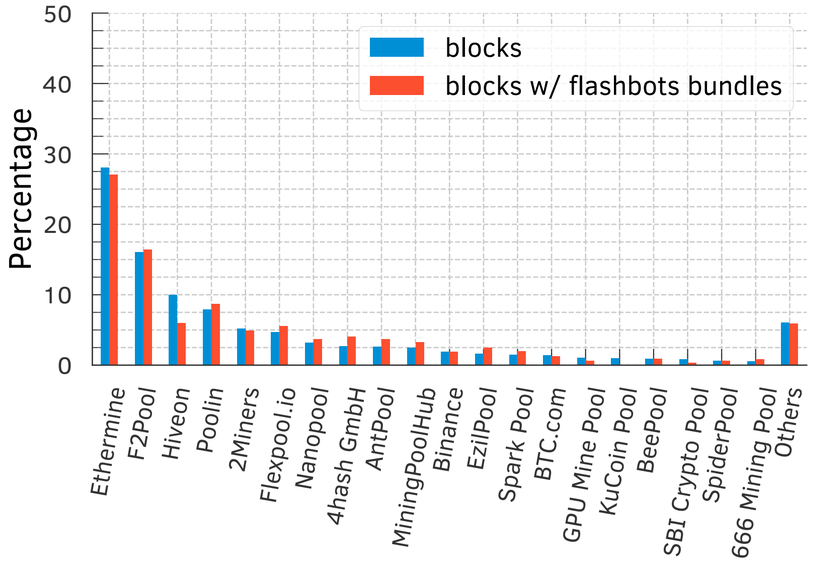
**Flashbots data set**
6,937,292 transactions in **3,284,886 bundles**

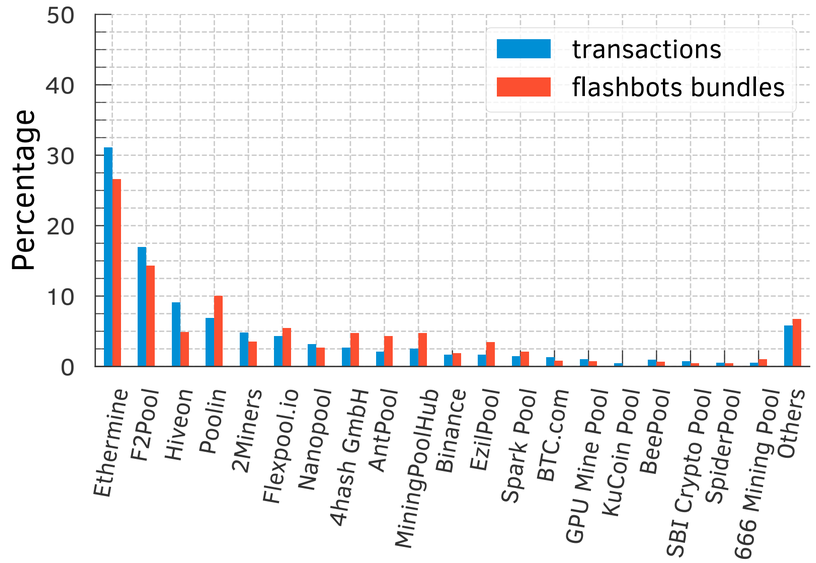
# Prevalence of Bundling

**Flashbots bundles are quite prevalent**

Ethermine included 27.05% of all blocks with a Flashbot bundle and 26.63% of all Flashbots bundles, while mining around 28.05% and 31.11% of all blocks and transactions, respectively.

**99.99% ETH hash-rate**



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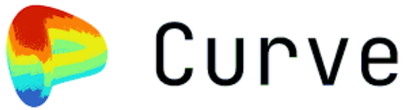
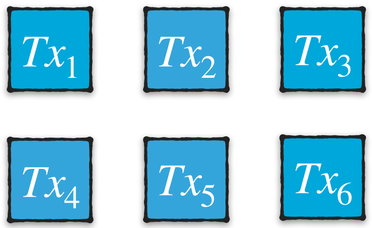





- We find that 2,231,051 (67.92%) unique Flashbots bundles and 3,076,760 transactions (44.35%) called at least one of these contracts.
  - Uniswap and SushiSwap were the most bundled DEXes protocols.

# Bundling Public Transactions

**Public transactions**




Alice

John


**Private transactions**

**Flashbots**

# Bundling Public Transactions

Alice

Public transactions

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$Tx_7$ $Tx_8$ $Tx_9$

Private transactions

Flashbots

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**Public transactions**

$Tx_1$ $Tx_2$ $Tx_3$

$Tx_4$ $Tx_6$

Alice

John

$Tx_8$ $Tx_9$

**Private transactions**

**Alice**

$Tx_5$

$Tx_7$

110,401 bundles

Flashbots

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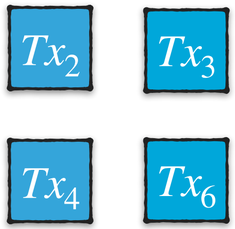


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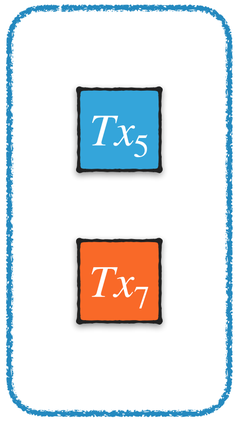


110,401 bundles

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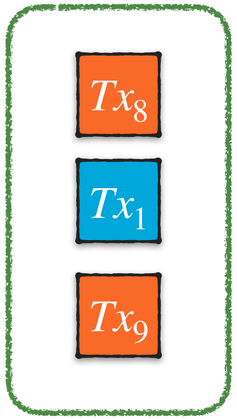


37,447 bundles

Sandwich attacks

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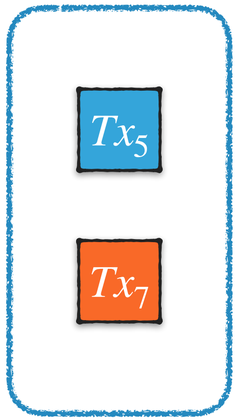


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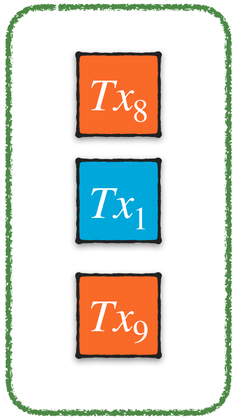


Sandwich attacks

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**Private transactions**

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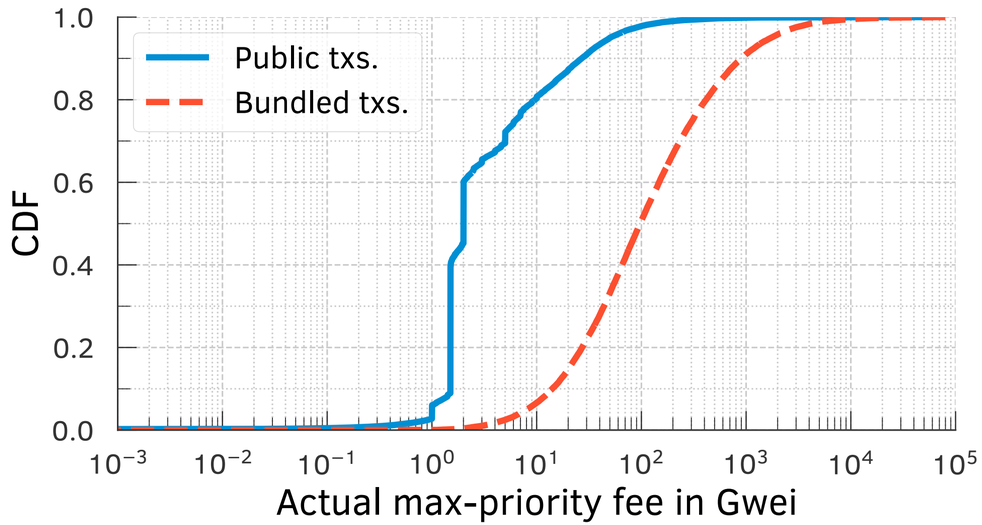
Bundles typically offer a larger effective fee to the miners



# Liquidation Through Bundling

- Over-collateralized lending protocols

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**Liquidations**

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6387

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- Over-collateralized lending protocols



| | Liquidations | Liquidations |
|---|---|---|
| | 16,418 | 6387 |
| Flashbots | 4863 | 2036 |

# Liquidation With Bundled Chainlink Oracle Updates

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**Liquidations**

1165 in 1154 bundles

Compound

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648 in 641 bundles

Flashbots

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One Oracle update 994 bundles

Followed by a liquidation

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- Over-collateralized lending protocols


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Two Oracle updates 52 bundles

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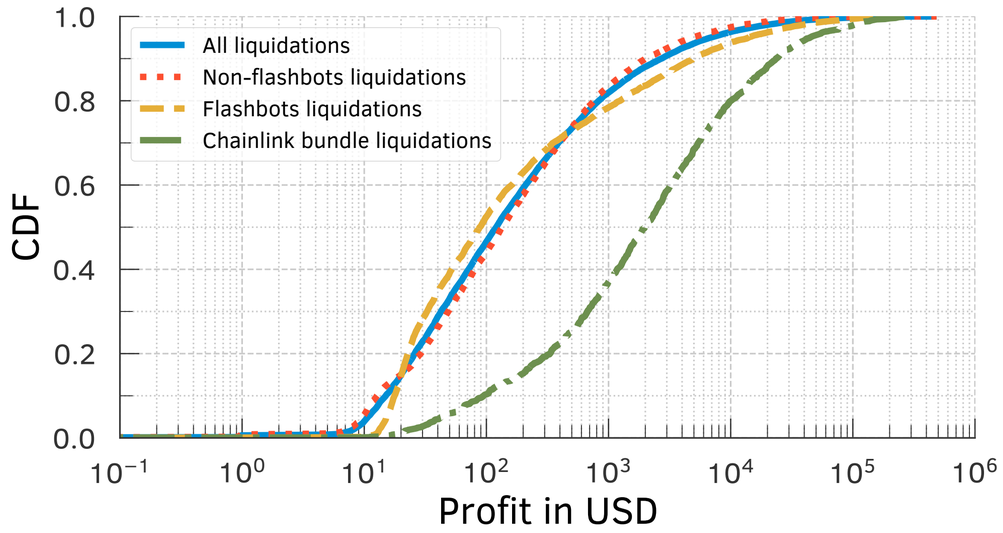
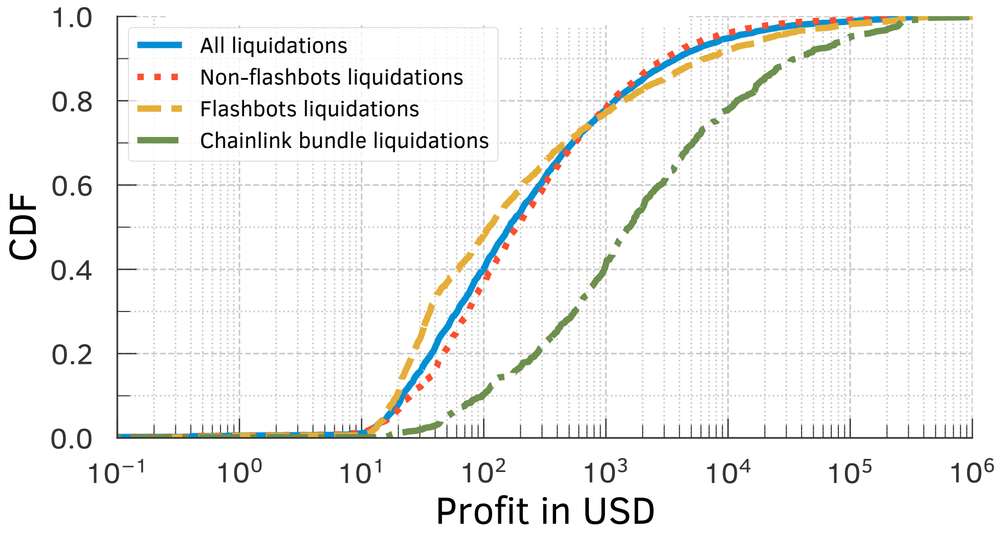
39 bundles

# Liquidation With Bundled Chainlink Oracle Updates

- Over-collateralized lending protocols




Profits are ~15x higher when compared to all liquidations when bundling with a Chainlink update

Chainlink We used Chainlink data feeds to convert the tokens to USD at the time of the liquidation

# Active Experiments

# Taichi Network: Private Transactions

SPARK POOL

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- While running the experiment, we checked if the popular blockchain explorers observed any of our private transactions.
  - if they did, it would imply that the Taichi Network leaked the transactions to the public.
  - Private transactions were only visible after they were committed.
    - Included in the expected block position based on the fees we offered.
  - SparkPool and Babel Pool included each 2 private transactions.

# Bitcoin Dark-Fees Transactions

- Active experiment
  - We took 10 snapshots of our MemPool during periods of high congestion.
  - We randomly selected only low-fee rate transactions with a size of 101 bytes for accelerating using ViaBTC transactions accelerator services.
    - 212 in total transactions.
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|---|---|---|---|---|
| | Acc. | Non-acc. | Acc. | Non-acc. |
| Minimum | 1 | 9 | 0.07 | 17.47 |
| 25-perc | 1 | 148 | 0.08 | 75.88 |
| Median | 2 | 191 | 0.09 | 87.92 |
| 75-perc | 2 | 247 | 0.20 | 95.00 |
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| AntPool | 12.5 % | 10.6 % | 10.2 % |
| Binance | 9.6 % | 10.3 % | 10.0 % |
| Huobi | 8.1 % | 9.3 % | 9.8 % |
| ViaBTC | 5.1 % | 7.1 % | 7.7 % |
| Total | 55.2 % | 56 % | 57.6 % |

**Mining pools with combined hash rates of over 50% were colluding to include these transactions!**

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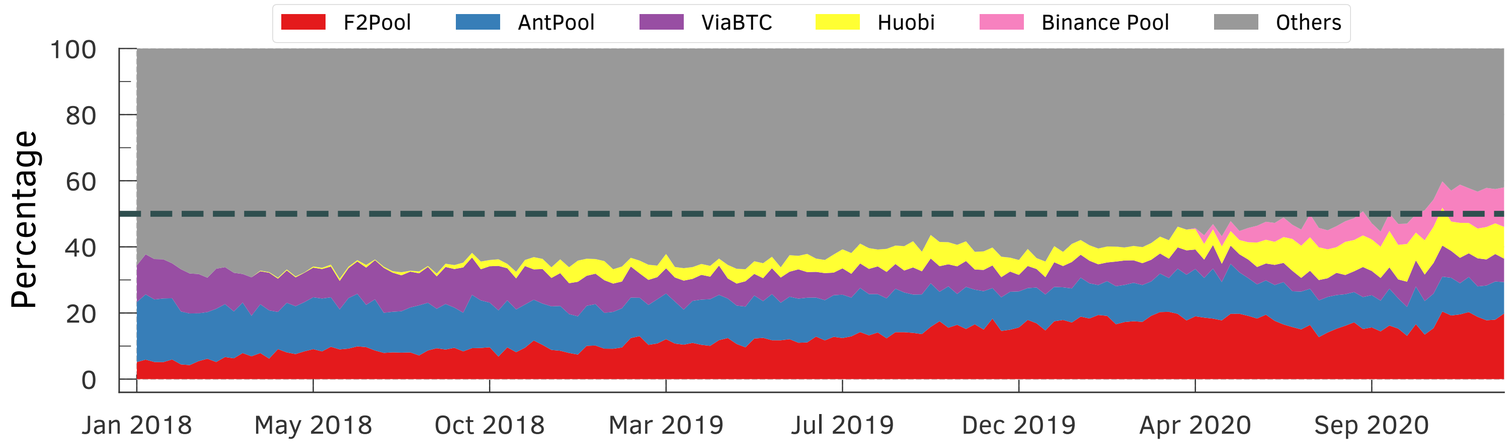


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- **Accelerated transactions:** transactions with SPPE ≥ 99%.
  - Many large mining pools such as BTC.com, F2Pool, and ViaBTC are likely including accelerated transactions.
  - ViaBTC including them in over 40% of their blocks.

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- Flashbots bundles are quite prevalent in Ethereum and are highly used for calling DEXes contracts to take advantage of MEV opportunities.
- Many large mining pools include accelerated transactions, with ViaBTC including it in over 40% of their blocks.
- Our observations still hold after the Merge.

# Our Data Set and Scripts Are Available

https://github.com/johnnatan-messias/blockchain-transaction-ordering


# Dissecting Bitcoin and Ethereum Transactions:
## On the Lack of Transaction Contention and Prioritization Transparency in Blockchains

Johnnatan Messias

@johnnatan_me

Joint w/ Vabuk Pahari, Balakrishnan Chandrasekaran, Krishna P. Gummadi, and Patrick Loiseau

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