



TopoShot: Uncovering Ethereum's Network Topology Leveraging Replacement Transactions

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Motivation: Why uncover Ethereum topology?

- Help understand Blockchain's **security**
 - Practical network attacks: e.g., eclipse attacks [SEC'15], single-point of failure, deanonymization attacks.
- Help understand Blockchain's **performance**
 - Mining efficiency and mining pools' quality of service (QoS), transaction relay service' QoS

Existing works focus on measuring Bitcoin[1], Monero[2]' topology. Measuring Ethereum is still an open problem.

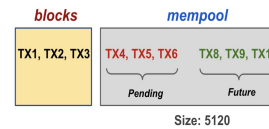
Preliminary: Ethereum memory pool

TX types - *nonce*

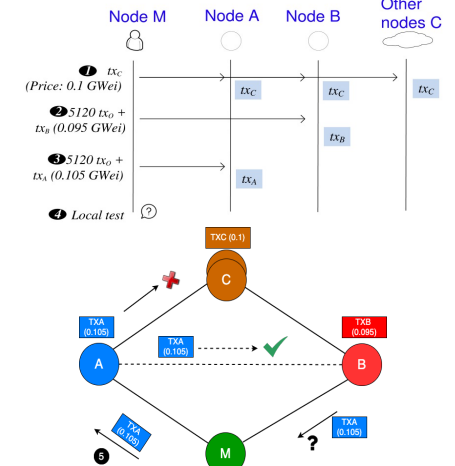
- Included (TX1..3)
- Pending (TX4..6)
- Future (TX8..10), **not profitable**
- Replacement: **same nonce but diff. Gas price**

Memory pool policies

- Replacement**
 - new Gas price $\geq 110\%$
 - for faster inclusion and defending against spam attacks
- Eviction**
 - new Gas price $>$ the lowest
 - for mining profit



Approach



Testnets Results

Ropsten graph

- 588 nodes, 7496 edges
- Compared with random graphs(Erdos-renyi, Barabasi-Alber, etc.)
 - fewer cliques and lower modularity.
 - more resilient to network partition attacks.

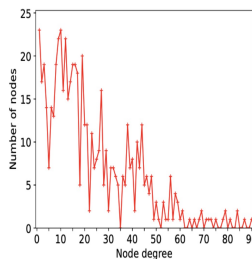


Table 4: Graph properties of the Ropsten testnet

	Measured Ropsten	ER (n = 588, m = 7496)	CM (n = 588, T = 26)	BA (n = 588, T = 26)
Diameter	5	3.0	5.2	3.0
Periphery size	56	291.5	24.9	589.4
Radius	3	3.0	3.0	2.0
Center size	56	291.5	51.7	78.6
Eccentricity	4.037	3.0	3.98	2.87
Clustering coefficient	0.207	0.044	0.139	0.139
Transitivity	0.127	0.044	0.122	0.136
Degree assortativity	-0.1517	0.026	-0.064	-0.0181
Clique number	60.75	290.3	557.4	56.6
Modularity	0.0605	0.161	0.152	0.102

Similar results on other testnets (Rinkeby, Goerli).

Mainnet Results

- SrvR1** connects to all **mining pools** and other **SrvR1** nodes.
- SrvR2** does not connect to any other services.
- All **mining pools** connect to the same pool and other pools.

Table 6: Connections among critical nodes

Type	Conn.	Type	Conn.
SrvR1- SrvM1	✓	SrvM1- SrvM1	✗
SrvR1- SrvM2	✓	SrvM1- SrvM2	✓
SrvR1- SrvM3	✓	SrvM1- SrvM4	✓
SrvR1- SrvM4	✓	SrvM1- SrvM3	✓
SrvR2- SrvM1	✗	SrvM2- SrvM2	✓
SrvR2- SrvM2	✗	SrvM2- SrvM3	✓
SrvR2- SrvM3	✗	SrvM2- SrvM4	✓
SrvR2- SrvM4	✗	SrvM3- SrvM4	✓
SrvR2- SrvR1	✗	SrvR1- SrvR1	✓

Network	Size (# of nodes)	Cost (Ether)	Date	Duration (hours)
Ropsten	588	0.067	Oct. 30, 2020	12
Rinkeby	446	2.10	Nov. 15, 2020	10
Goerli	1025	0.62	Oct. 20, 2020	20
mainnet	9	0.05858	May. 15, 2021	0.5

Summary

- Toposhot is the first work uncovered Ethereum topology
- Repurpose transaction eviction and replacement policies
- Local validation shows a perfect precision and high recall
- Interesting results on real Ethereum networks

References

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