What Peer Announcements Tell Us About the Size of the Bitcoin P2P Network

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What is the Size of Bitcoin?

$39,846.13
Bitcoin Price [1]

403,984 MB
Blockchain Size [2]

$758,296,996,808
Market Cap [1]

15,519
Reachable Peers [3]

?

19,030,631
Total Circulating Bitcoin [1]

Total Number of Peers
in the P2P Network

250,160
Transactions per Day [2]

https://coinmarketcap.com/currencies/bitcoin/ [1]
https://www.blockchain.com/charts#currency [2]
https://bitnodes.io/ [3]

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Motivation

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┌─────────────────┐         ┌─────────────────┐         ┌─────────────────┐
│  Total number   │         │    Block and    │         │   Security of   │
│  of peers in    │ ──────▶ │   transaction   │ ──────▶ │    Bitcoin      │
│  P2P network    │ influences [1] │ propagation │ influences [2] │            │
└─────────────────┘         └─────────────────┘         └─────────────────┘
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[1] Shahsavari, Y., Zhang, K., Talhi, C.: A Theoretical Model for Block Propagation Analysis in Bitcoin Network. IEEE Transactions on Engineering Management (2020).

[2] Garay, J., Kiayias, A., Leonardos, N.: The Bitcoin Backbone Protocol: Analysis and Applications. EUROCRYPT 2015.

Counting Peers in the P2P Network

OPEN

for incoming connections

CLOSED

for incoming connections

Collect addresses known by peers in the P2P Network

Reachable Peers

Unreachable Peers

We can connect to reachable peers and count them

See https://bitnodes.io and
https://dsn.kastel.kit.edu/bitcoin

We cannot distinguish whether there is an unreachable peer or no peer at an address

Estimating Number of Unreachable Peers

Run reachable peers and observe unreachable peers that connect to them.
See Wang, L., Pustogarov, I.: Towards Better Understanding of Bitcoin Unreachable Peers. arXiv:1709.06837 (Sep 2017).
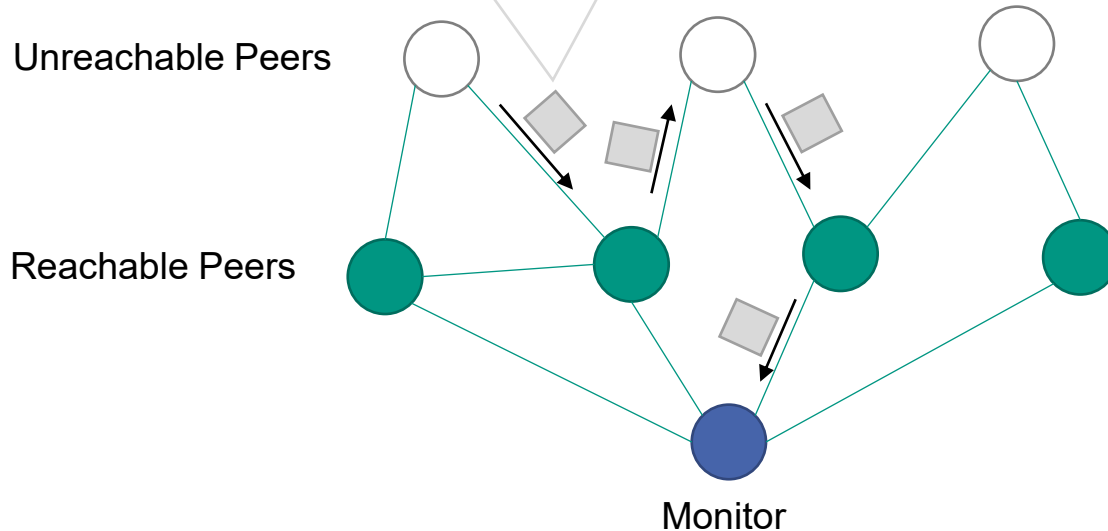
or

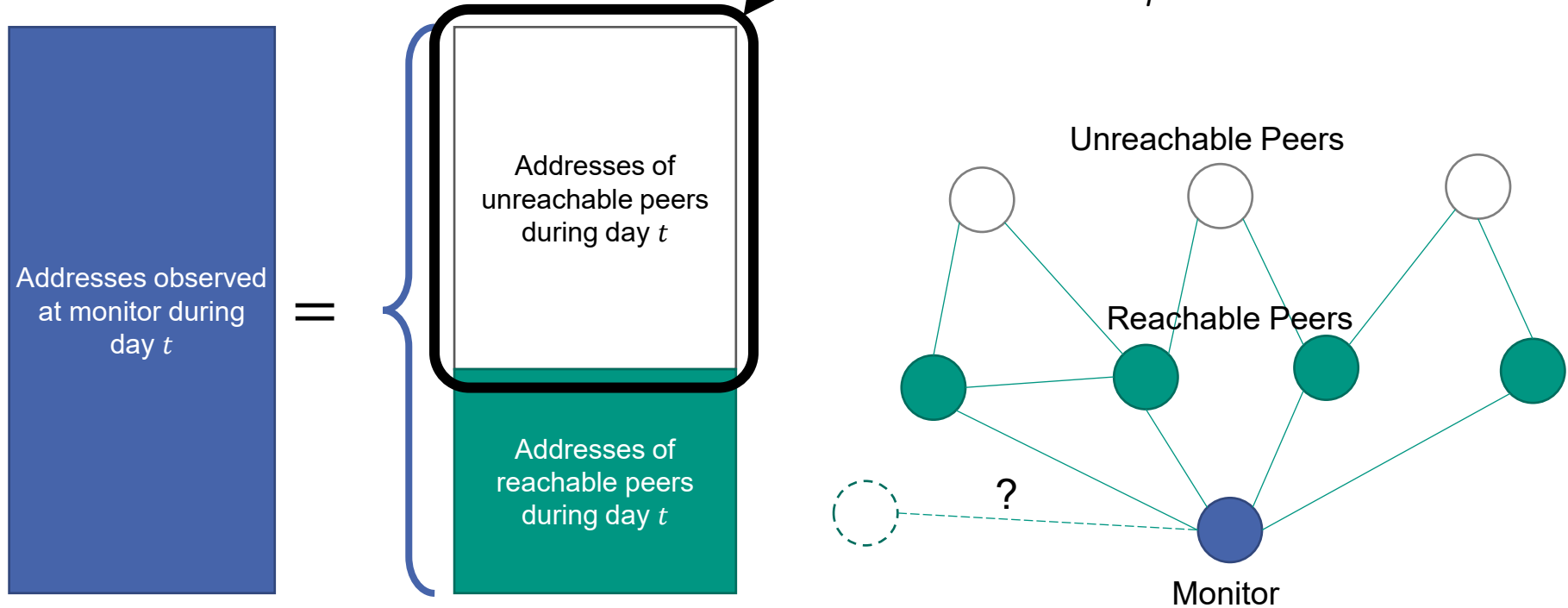Observe peer announcements sent by unreachable peers.
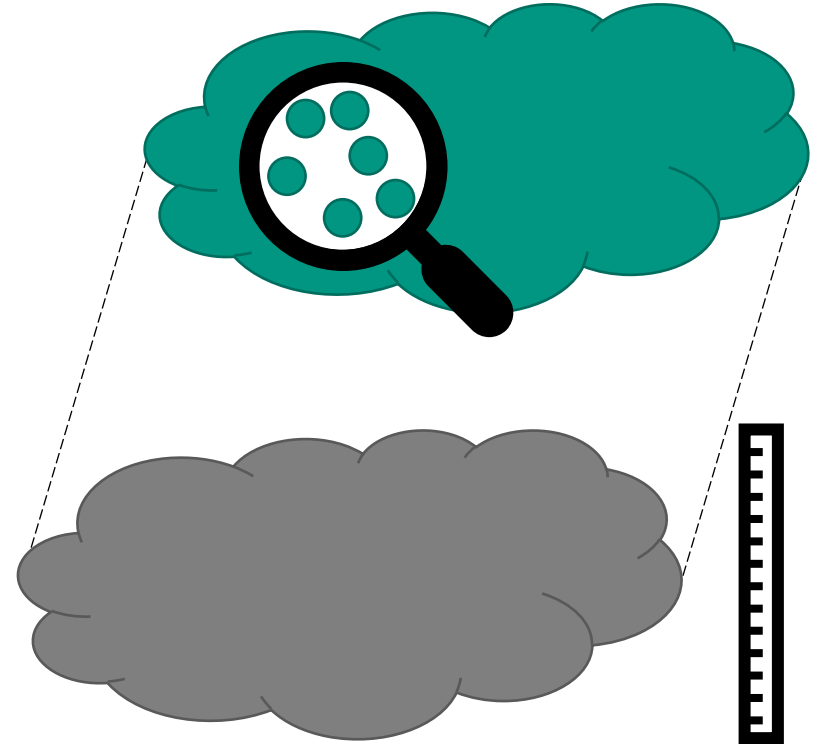
Peer Announcements

Address: 129.13.189.200
Timestamp: 7/19/2022 12:43 PM
Service Flags: 101101101

Unreachable Peers

Reachable Peers

Monitor

- Peers regularly announce their address to their peers.

- Peers forward peer announcements until they are older than ten minutes.

- With a global monitor, we can observe peer announcements.

- **Passive Announcement Listening (PAL) Method**: Estimate set of unreachable peers from peer announcements observed at global monitor.

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Data Analysis

The size of this set
is the number of
unreachable peers

Addresses observed at monitor during day t
$=$
Addresses of unreachable peers during day t

Addresses of reachable peers during day t

Unreachable Peers

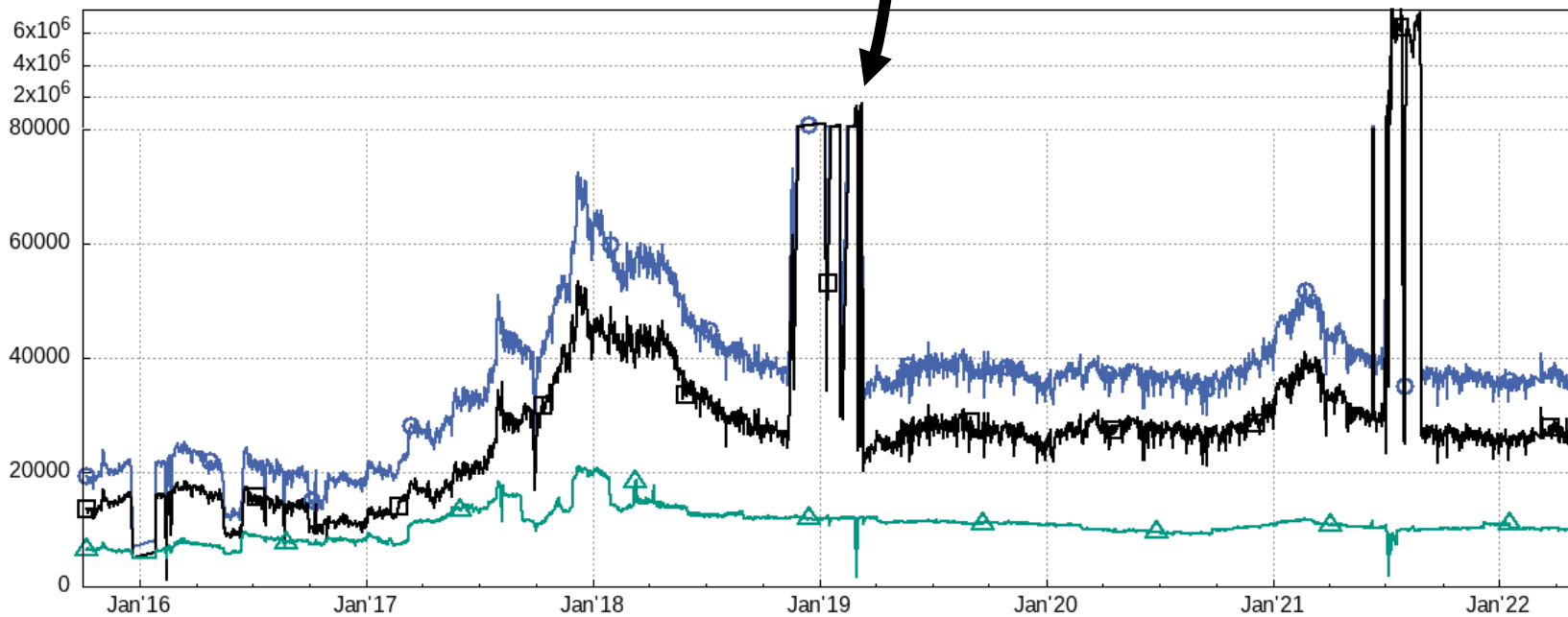Reachable Peers

?

Monitor

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Measurements

Spam of bogus addresses

Analyzed in "On the Peer Degree Distribution of the Bitcoin P2P Network". Grundmann, Baumstark, Hartenstein. IEEE ICBC 2022
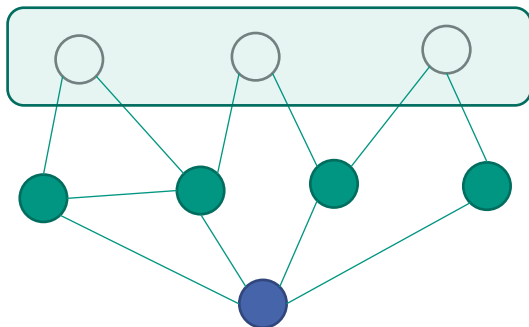
Number of addresses observed at monitor per day
Number of addresses of unreachable peers per day
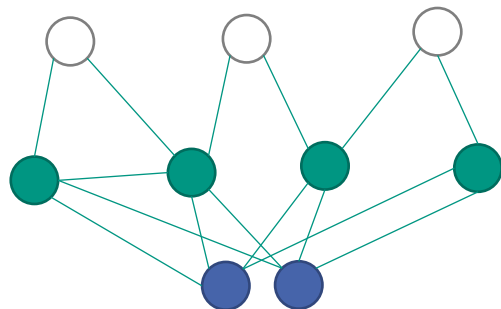
Number of reachable addresses per day

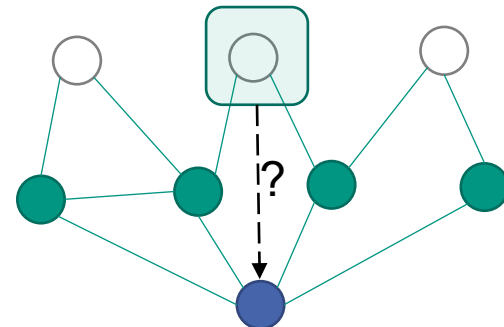Currently, about 26,000 unreachable peers

Validation

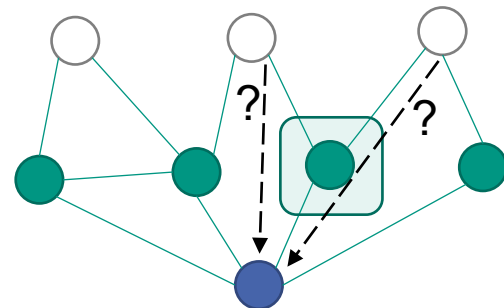The monitor observed the addresses of 95 % of **reachable peers** per day.

The address of one of our **own unreachable peers** was observed on 94 % of days.

A **second monitor** in a different location observed on average 96 % the same addresses.

The monitor observed the addresses of 94 % of the unreachable peers that announce themselves and connected to our **own reachable peer**.

Conclusion

- Passive Announcement Listening Method observes addresses of unreachable peers.
    - → Estimation of about 26,000 unreachable peers that announce their address

- Only about 75 % of unreachable peers announce their address
    - → We estimate that there are currently about **35,000 unreachable peers**.

- Continuously updated results at https://www.dsn.kastel.kit.edu/bitcoin/#addresses

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Bitcoin Monitoring

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