

Empirical insights into Bitcoin's P2P network

Advancing Bitcoin Conference 2023, London

virtu

DNS seeds

- Why care about DNS seeds?

DNS seeds

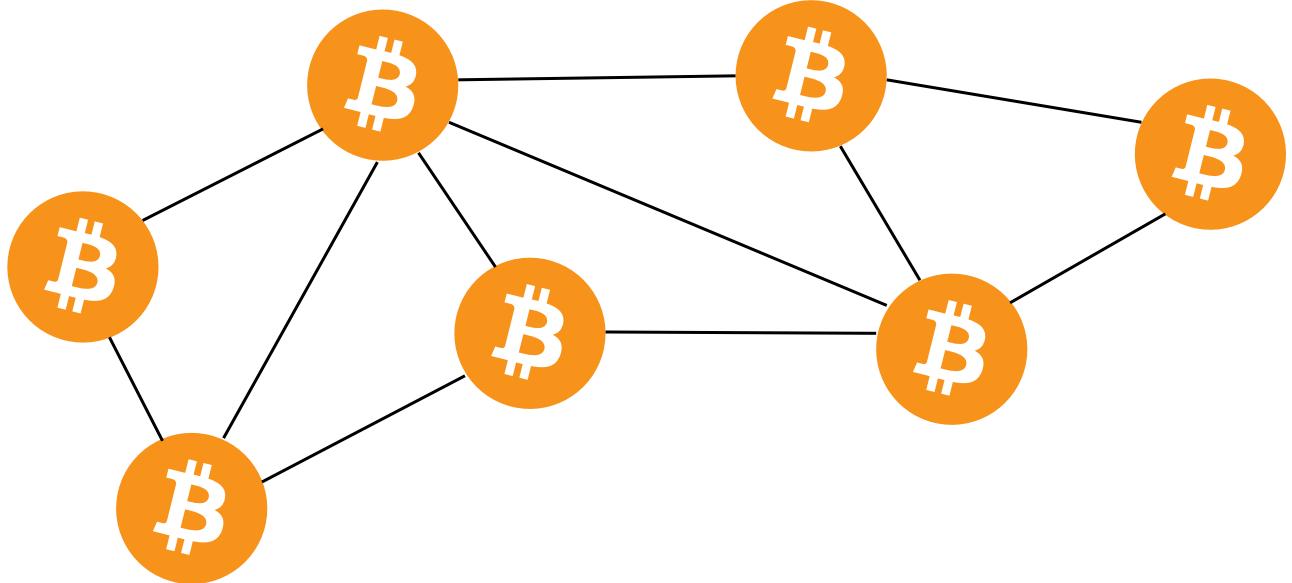
- Why care about DNS seeds?
 - Default way to bootstrap new nodes

DNS seeds

- Why care about DNS seeds?
 - Default way to bootstrap new nodes
- Node discovery using DNS seeds

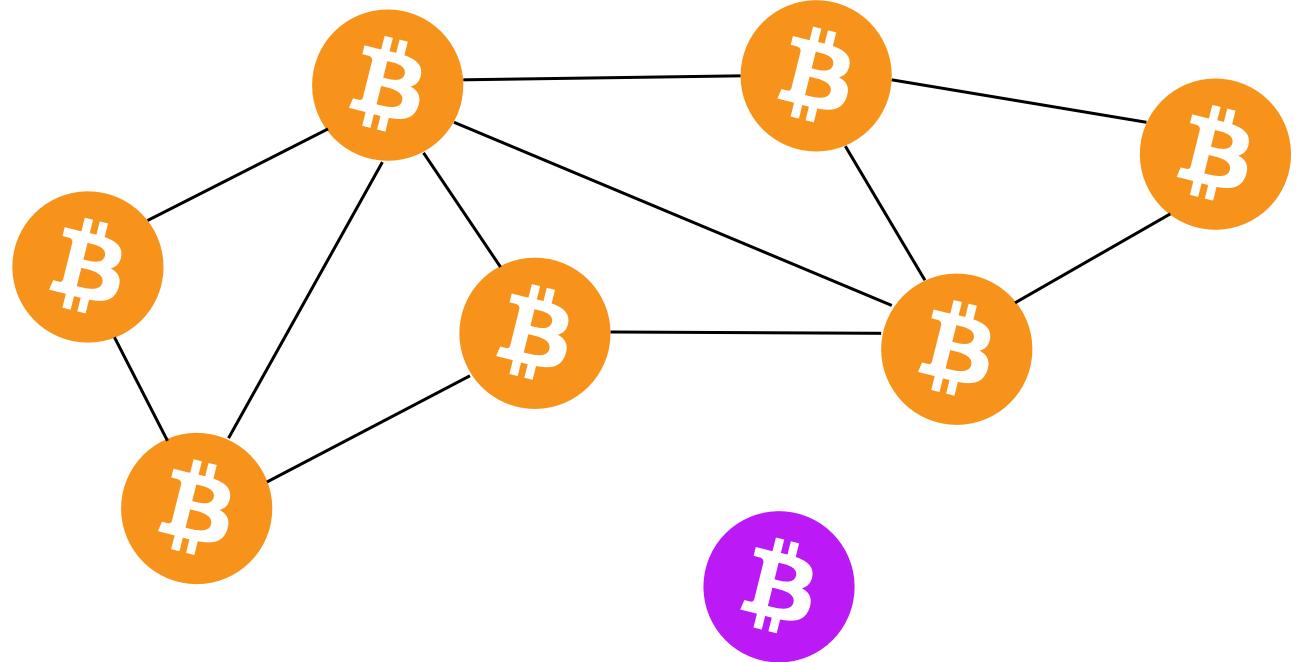
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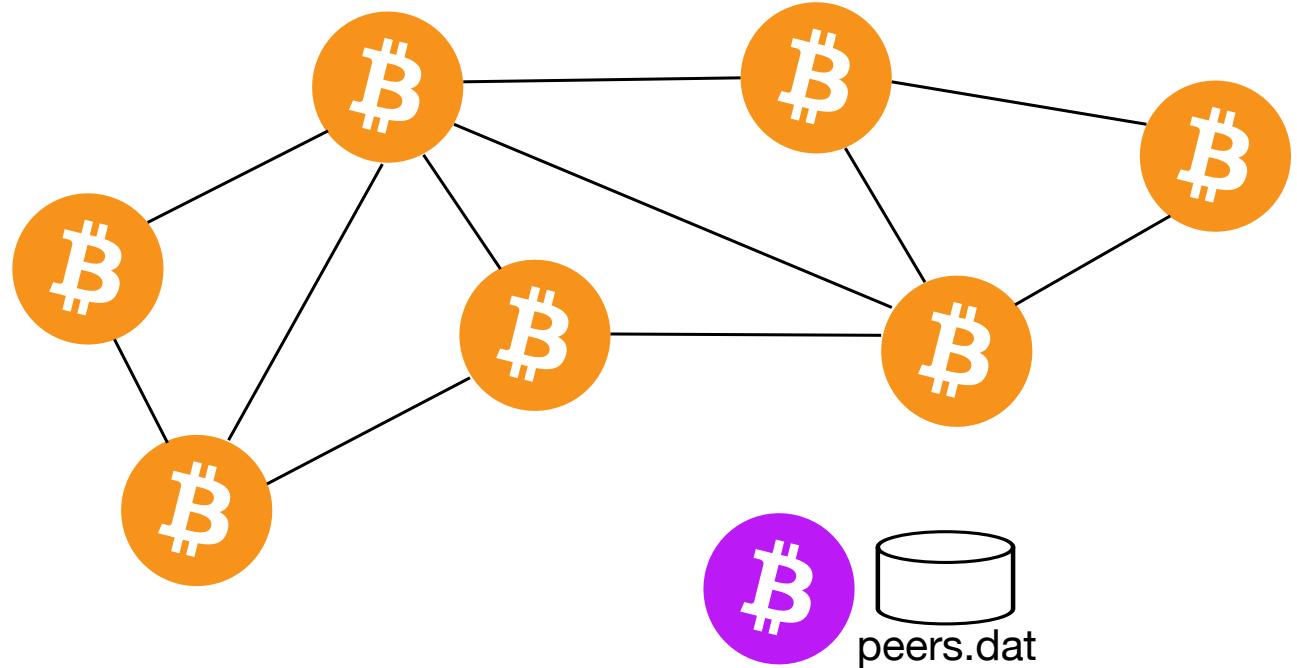
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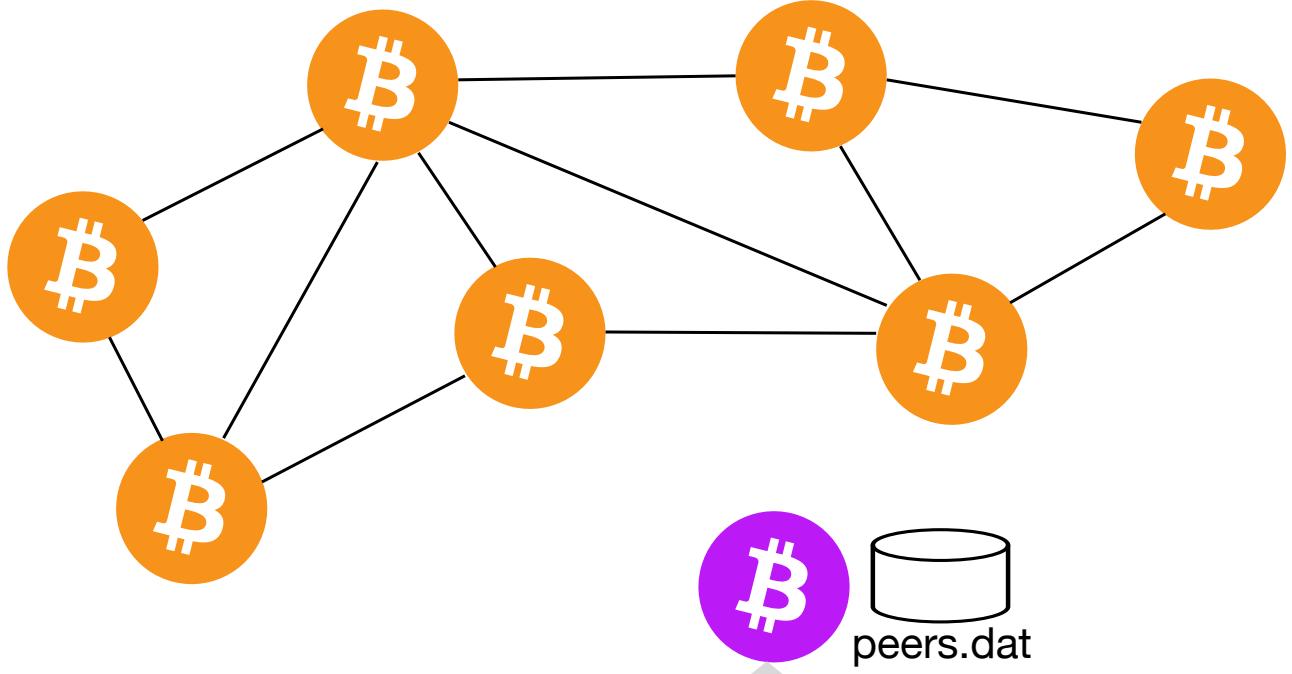
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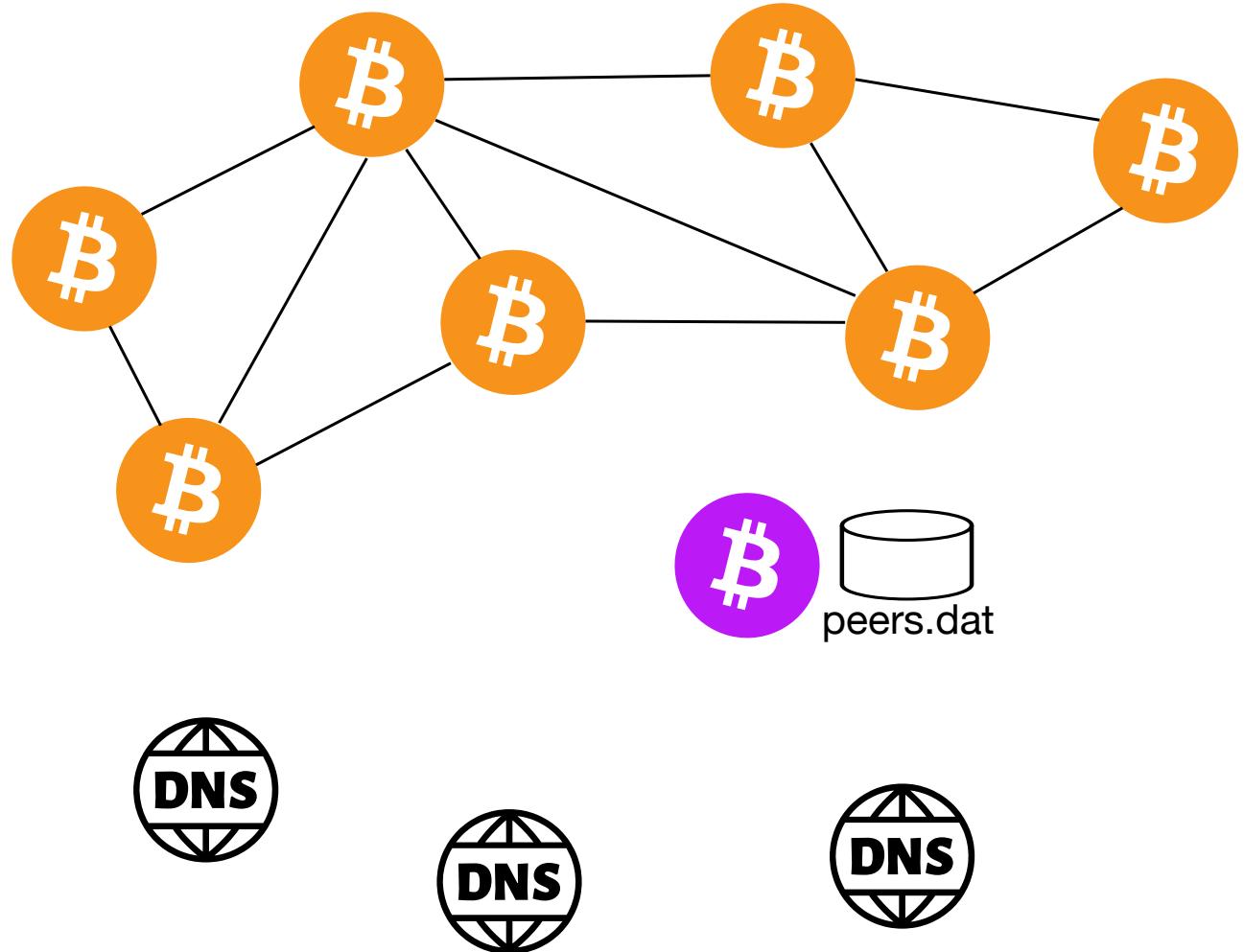
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```
src/chainparams.cpp:  
vSeeds.emplace_back("seed.bitcoin.sipa.be.");  
vSeeds.emplace_back("dnsseed.bluematt.me.");  
vSeeds.emplace_back("dnsseed.bitcoin.dashjr.org.");  
[...]
```

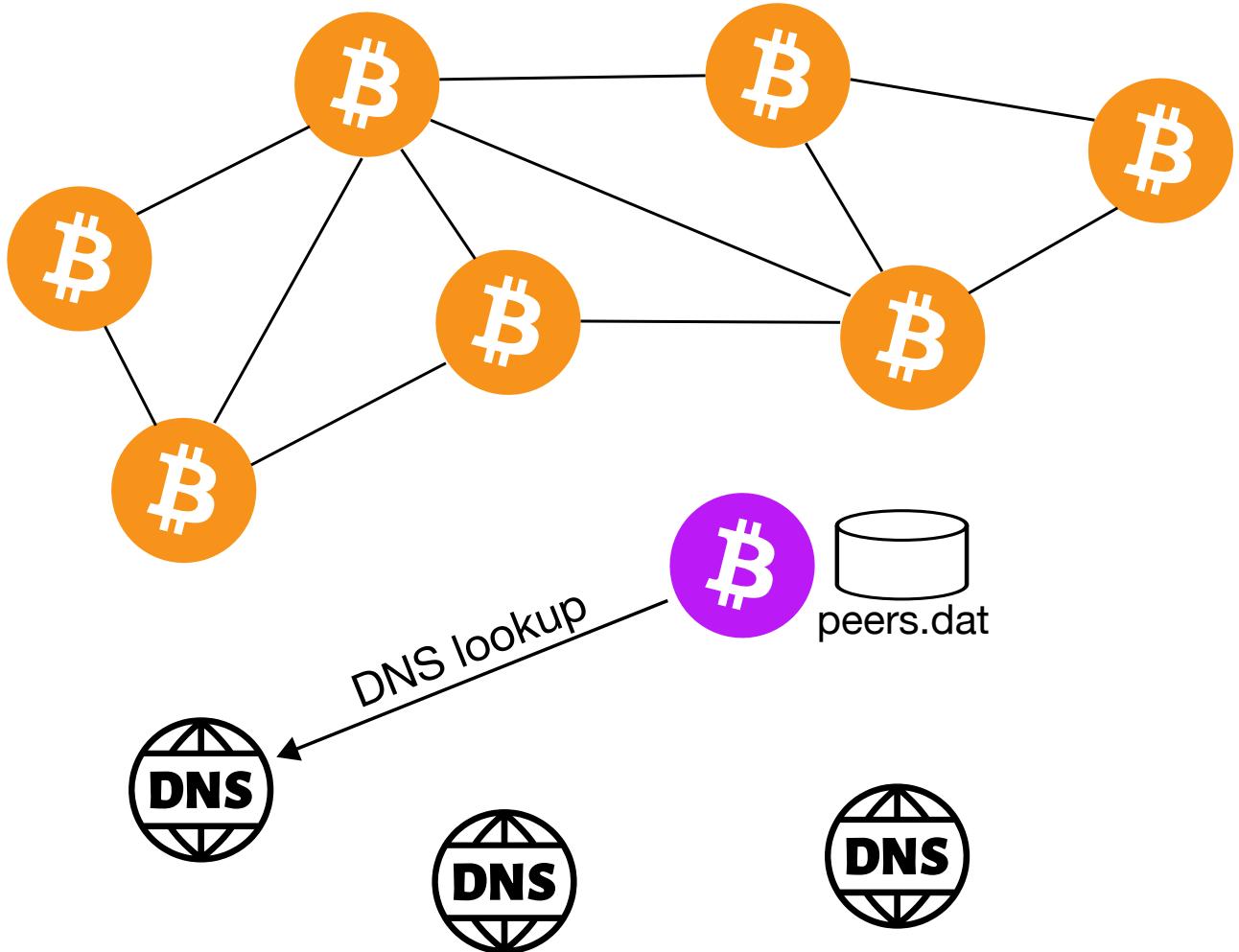
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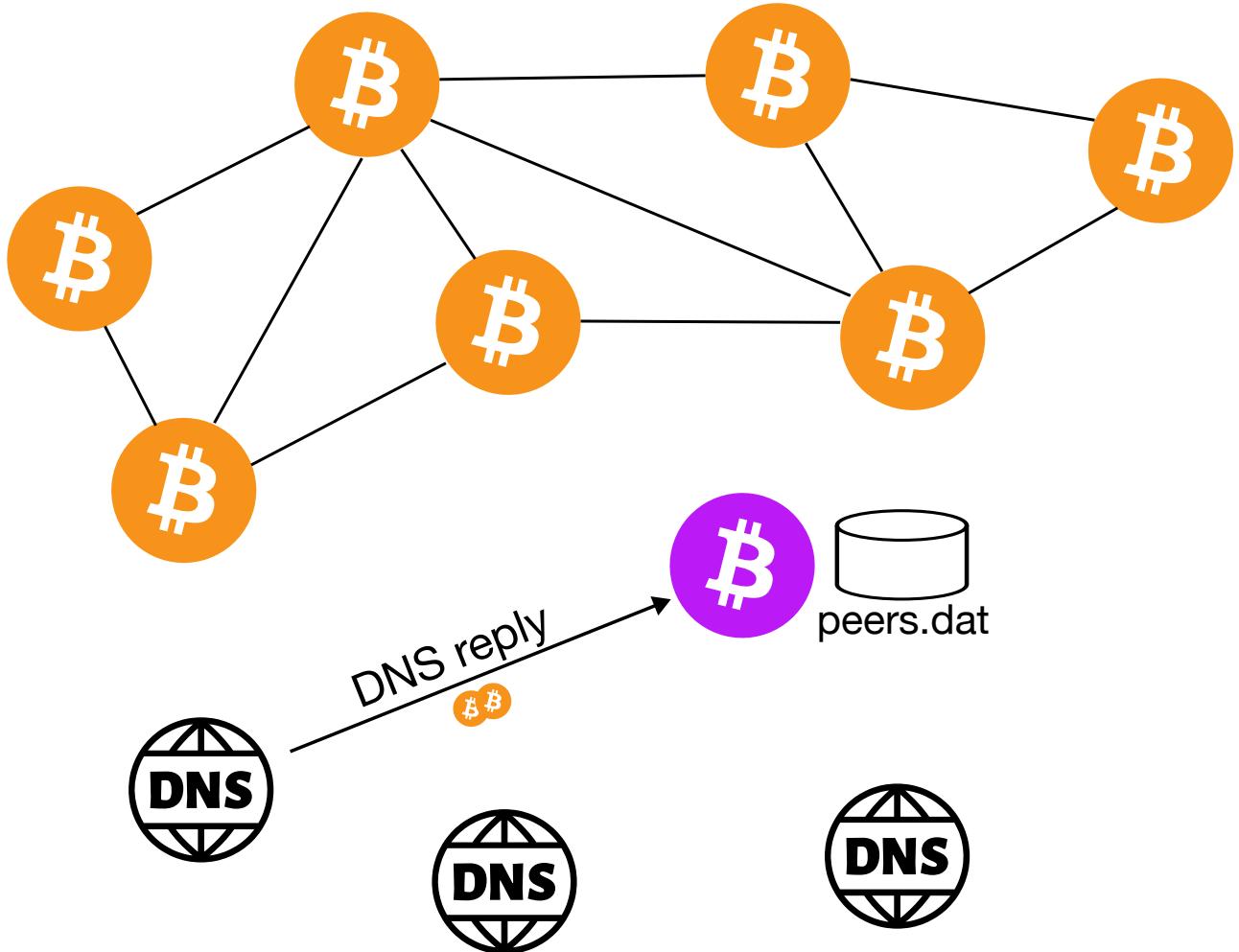
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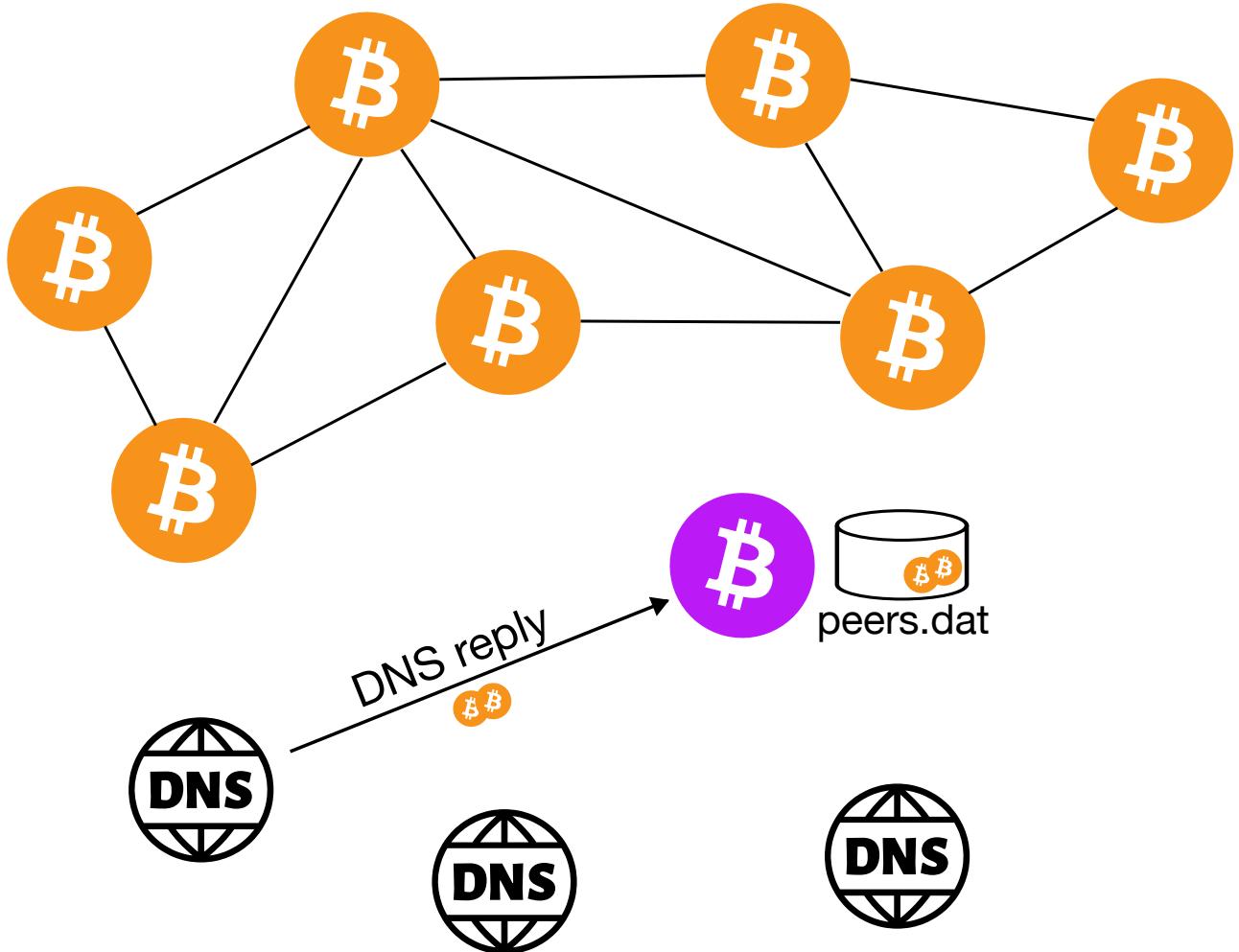
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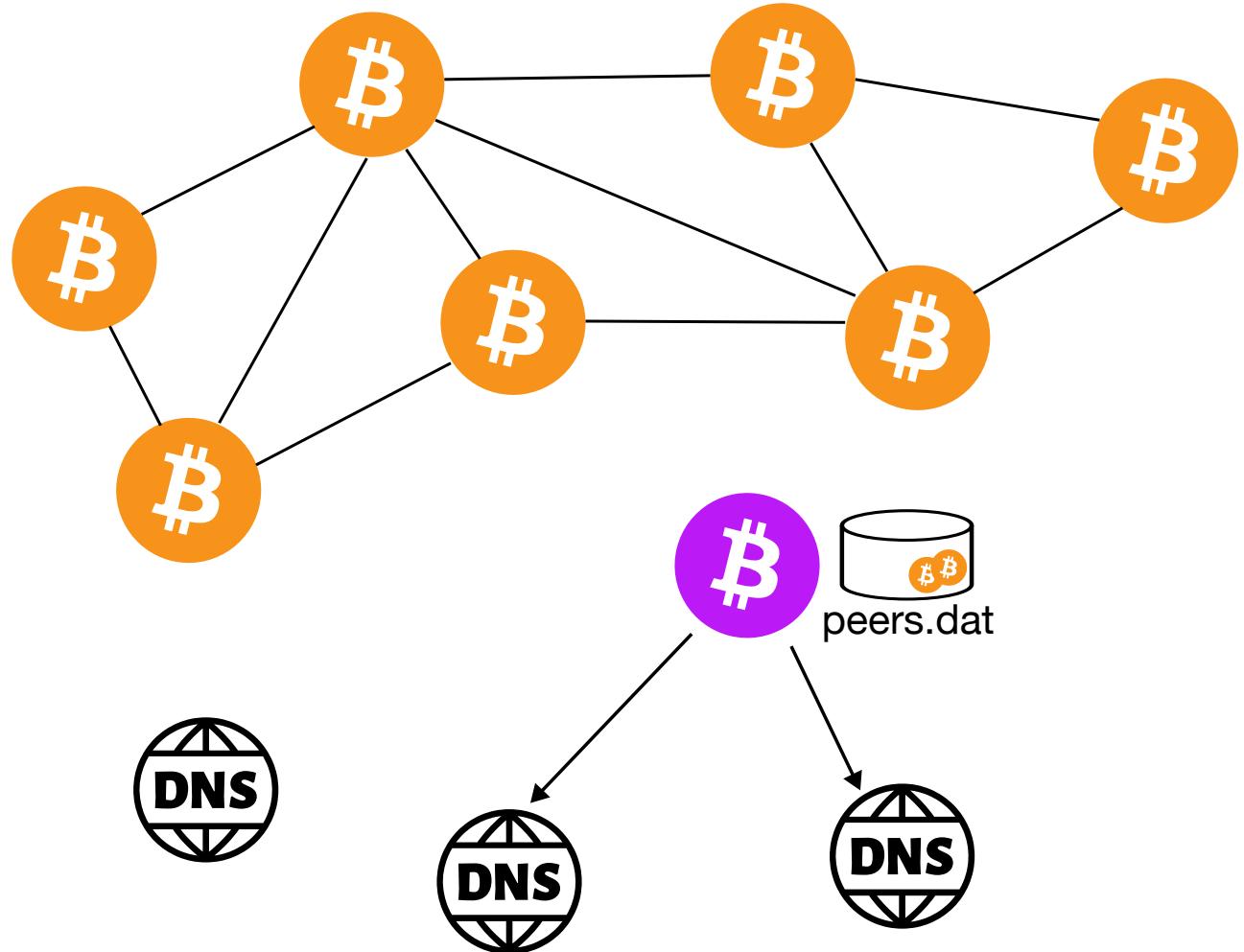
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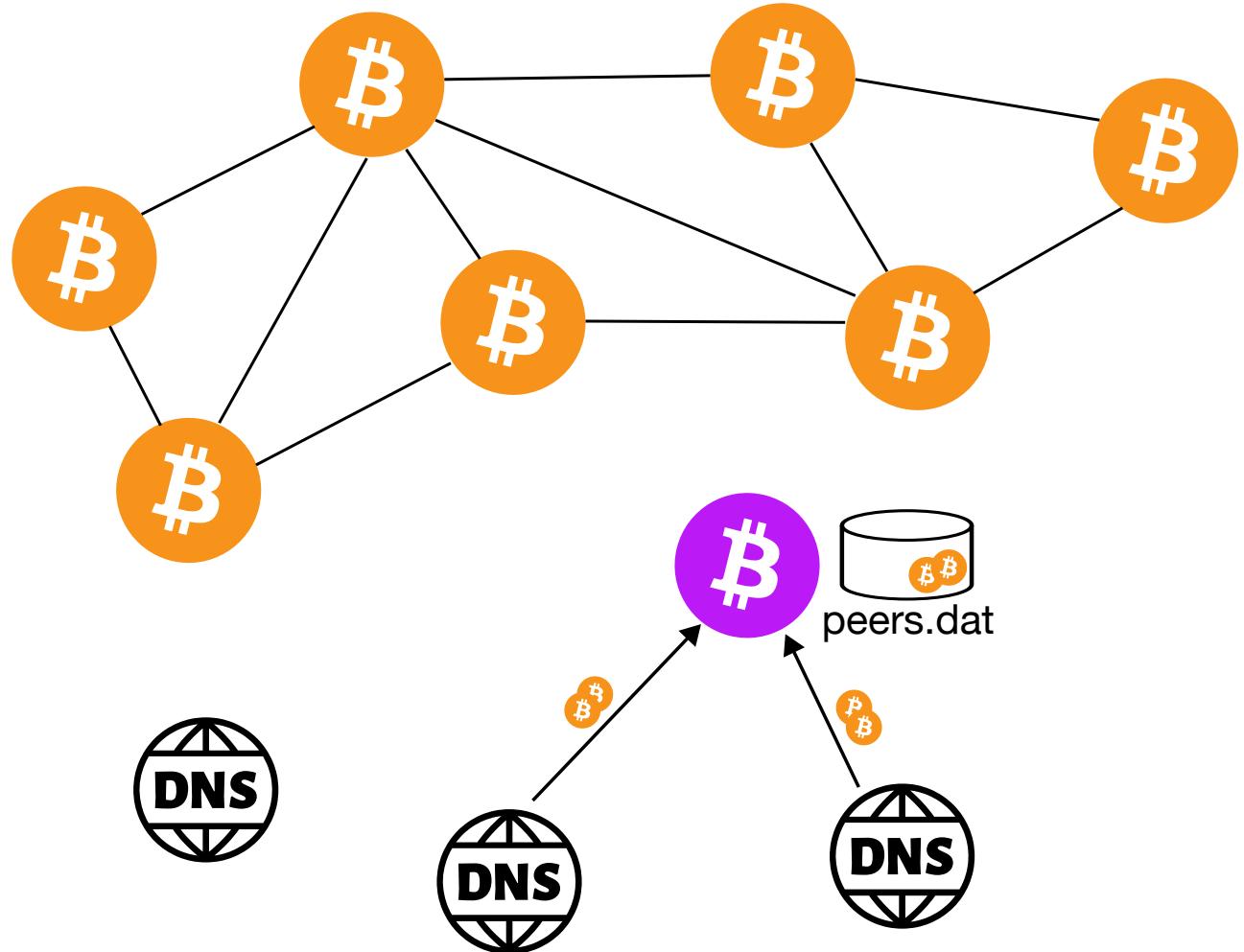
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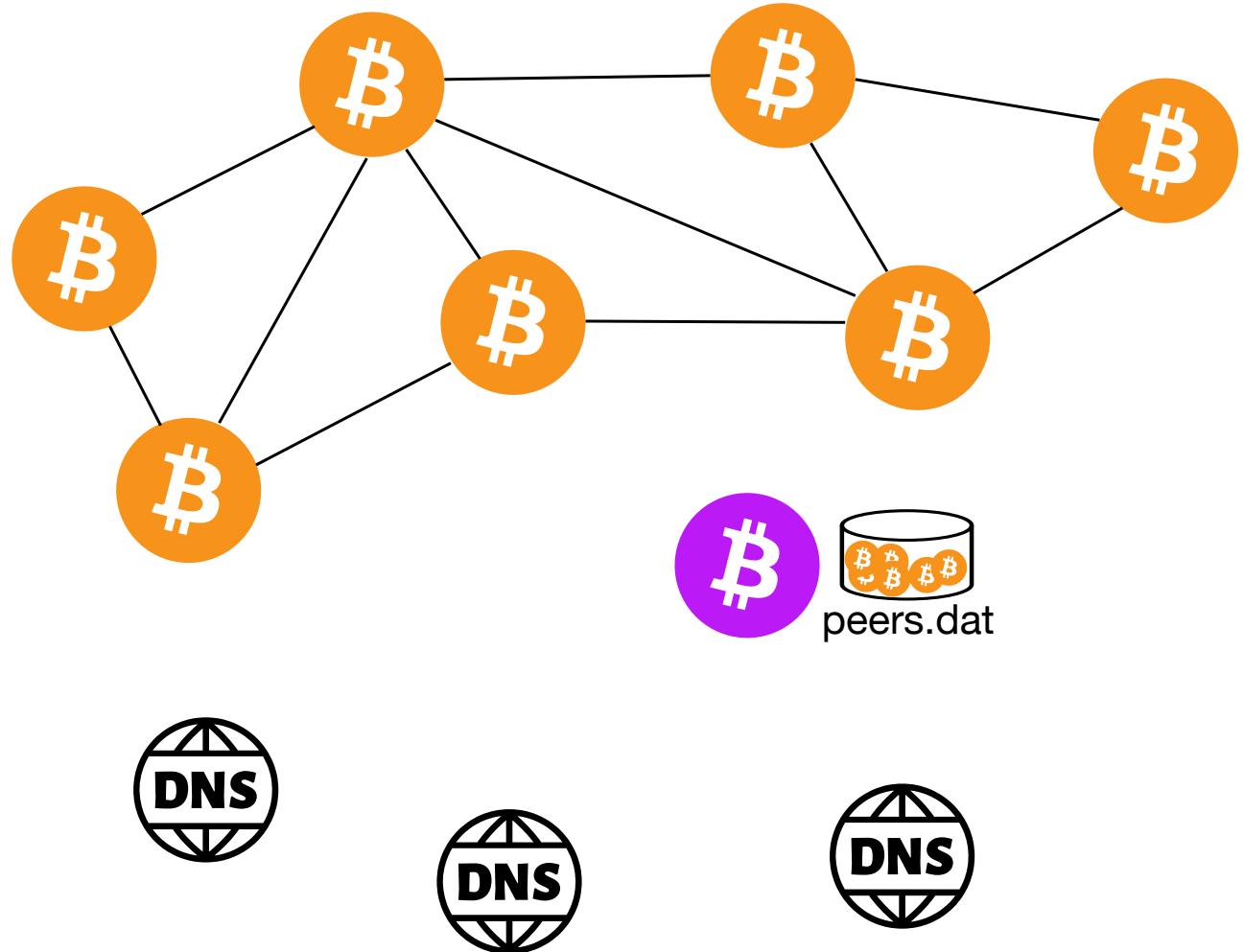
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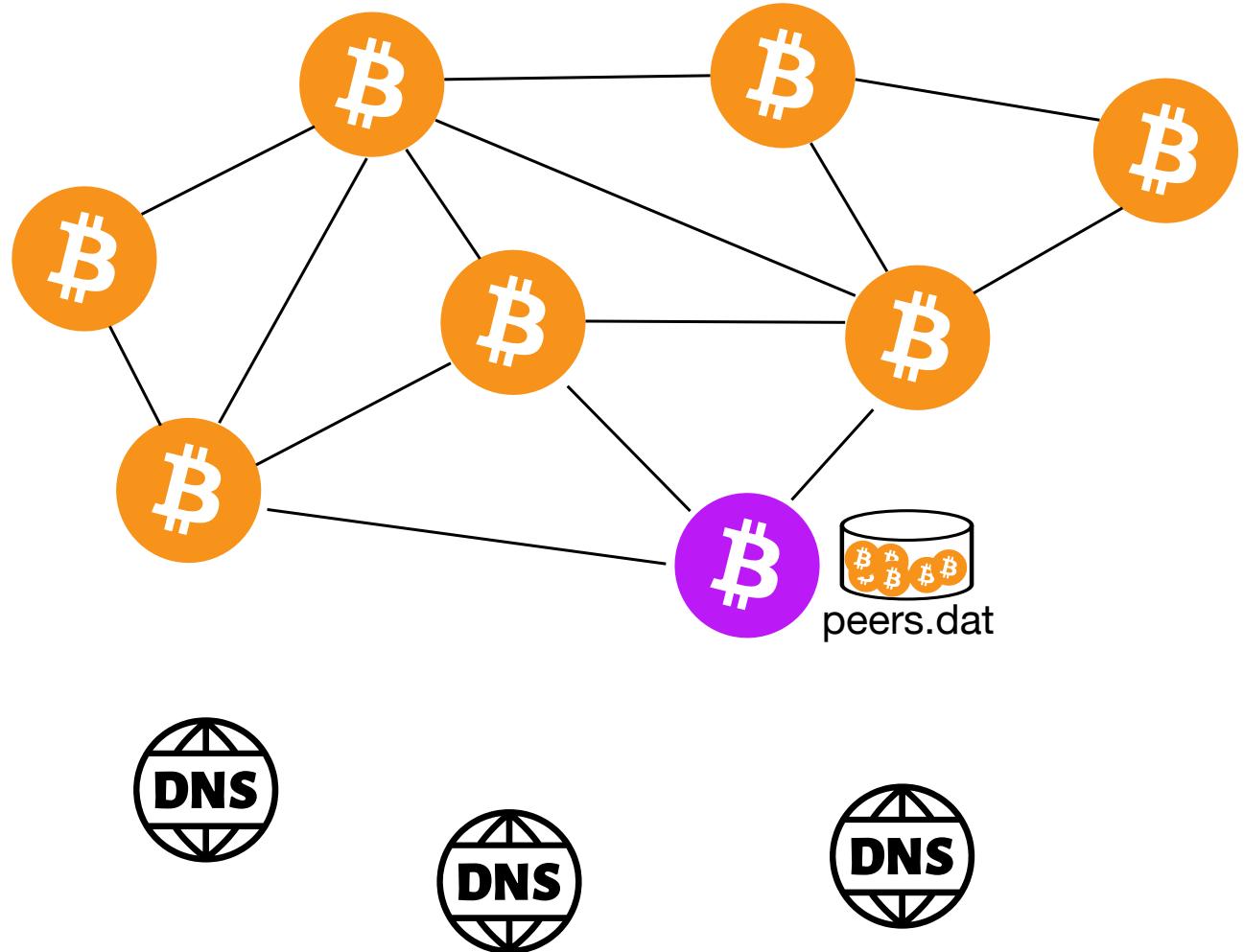
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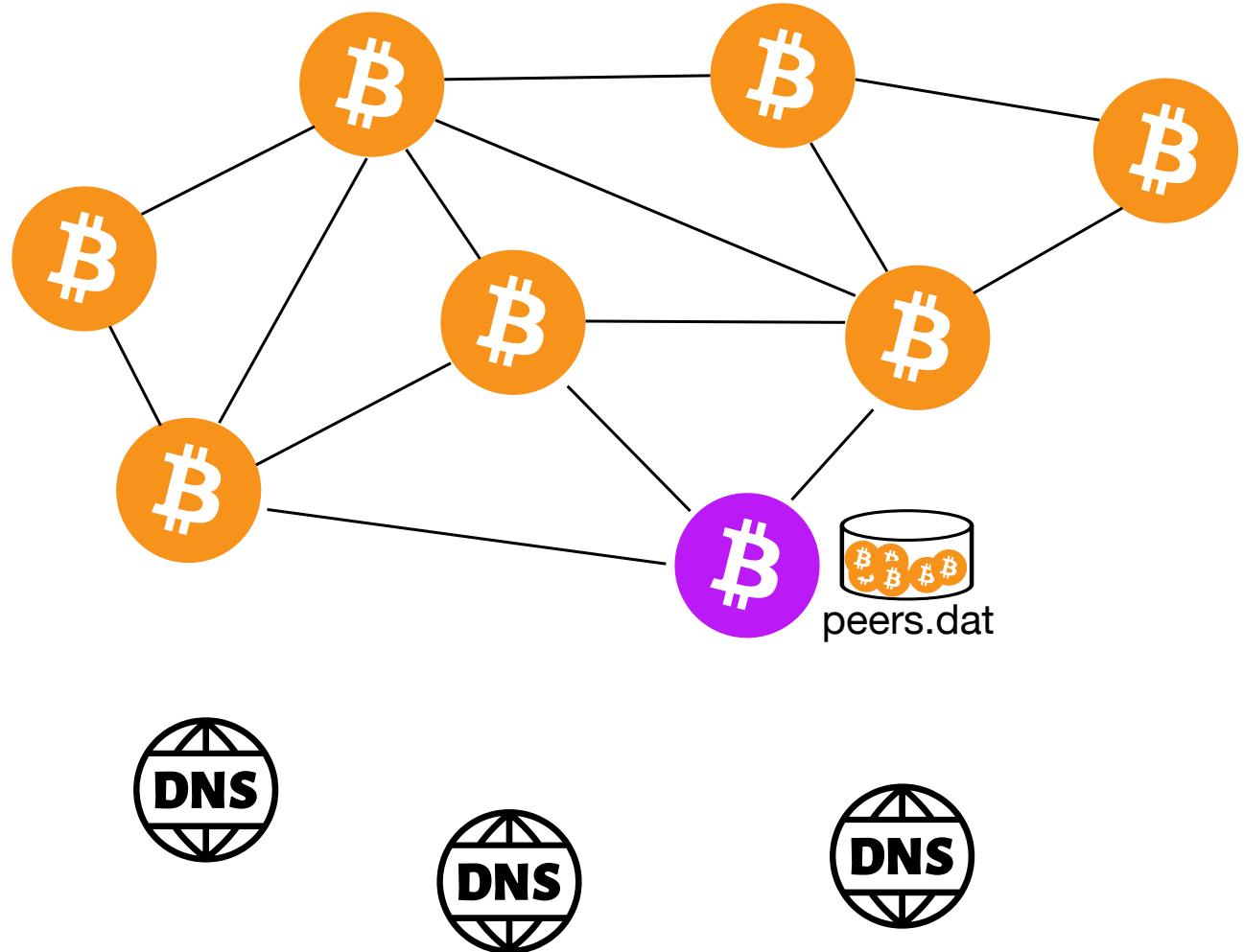
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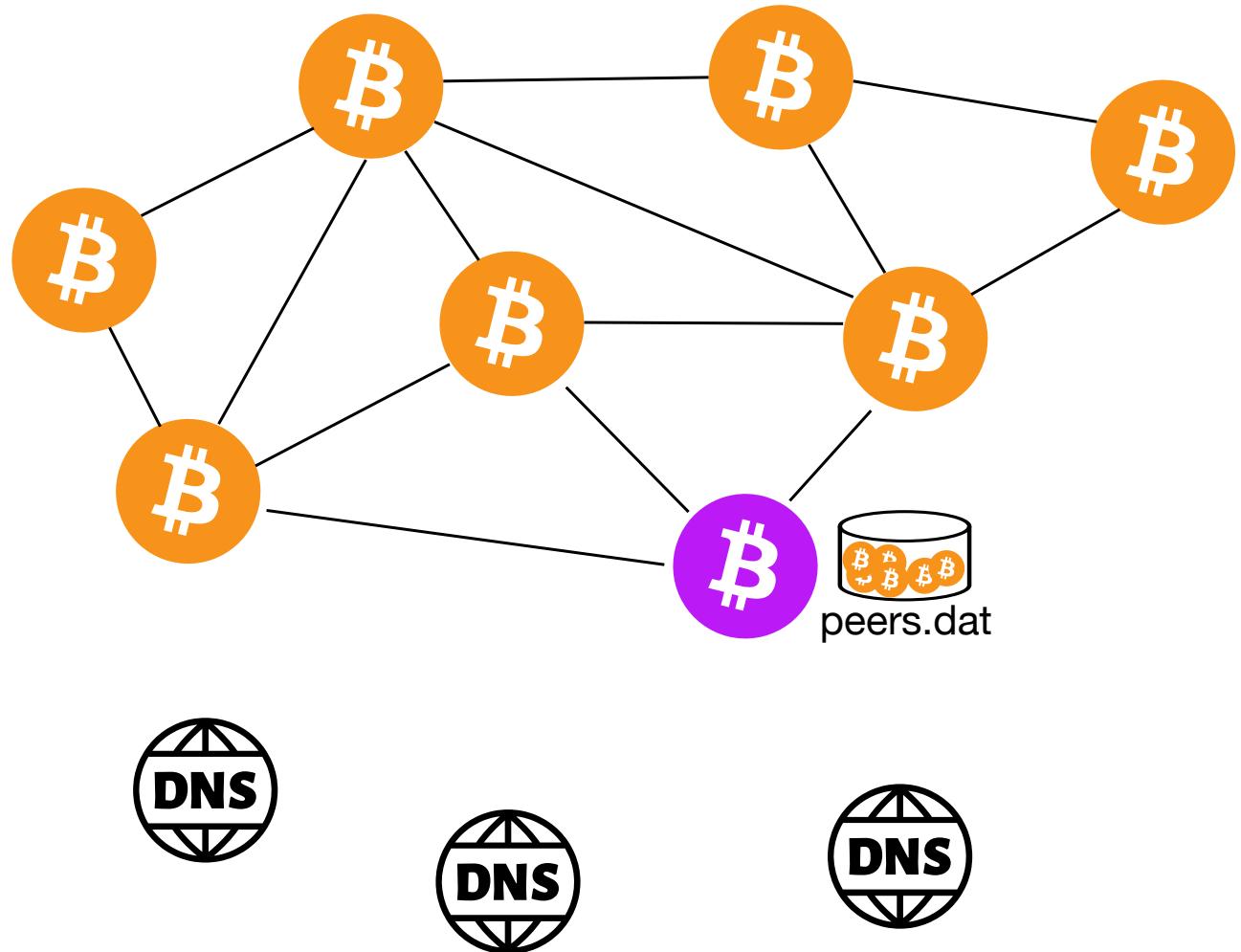
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- Why care about DNS seeds?
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- Node discovery using DNS seeds
- DNS seed requirements



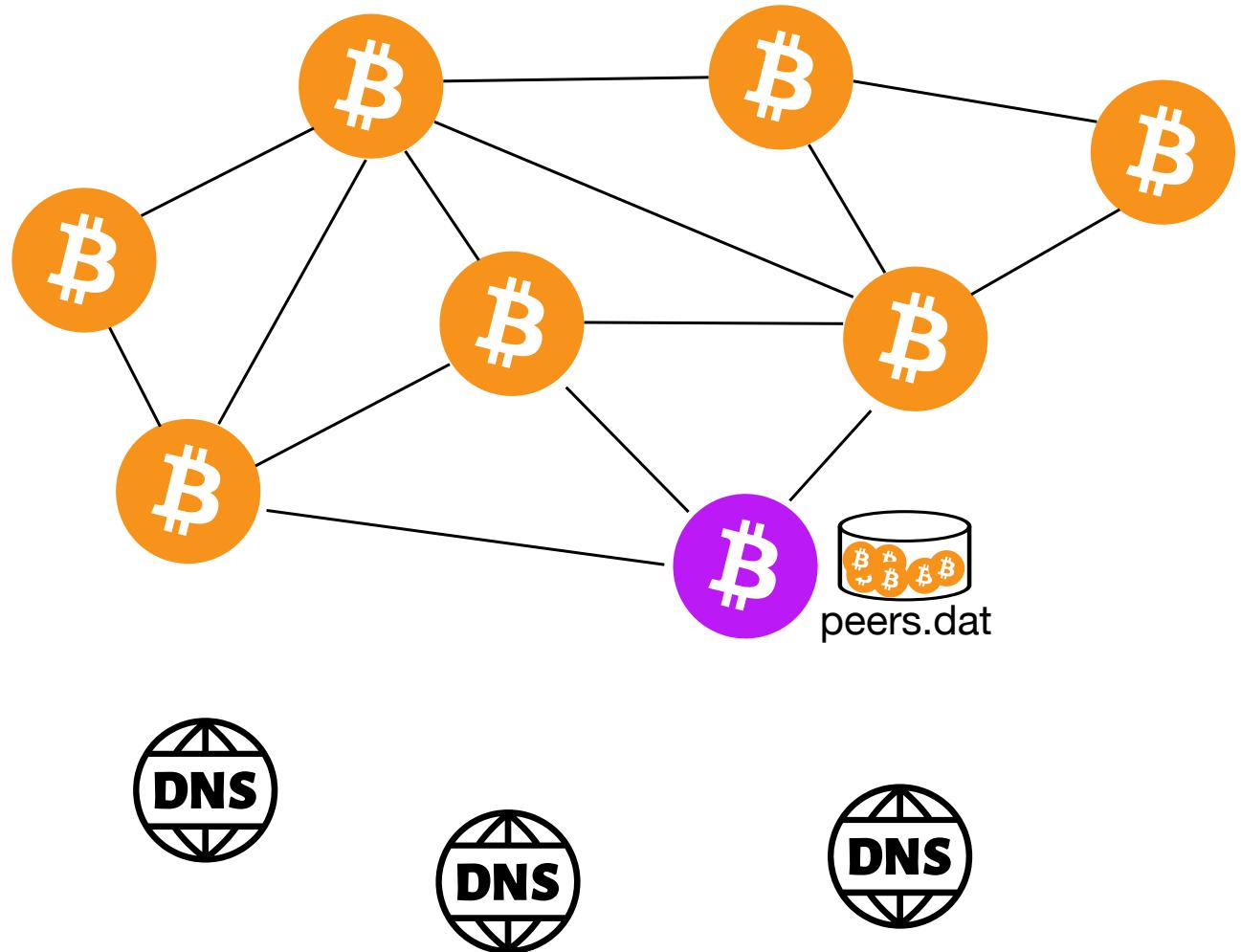
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- Why care about DNS seeds?
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- DNS seed requirements
 - Uptime



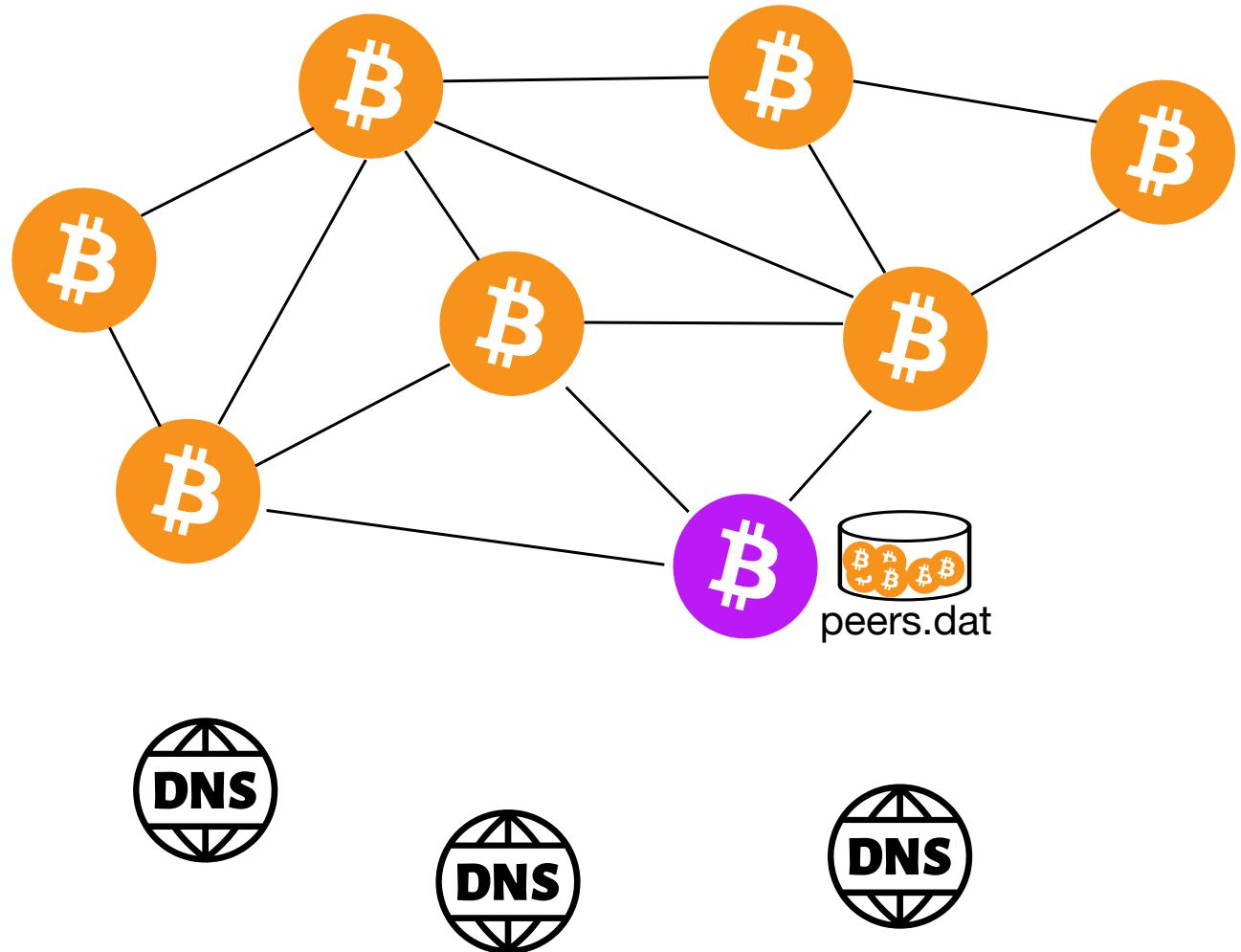
DNS seeds

- Why care about DNS seeds?
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 - Advertised nodes



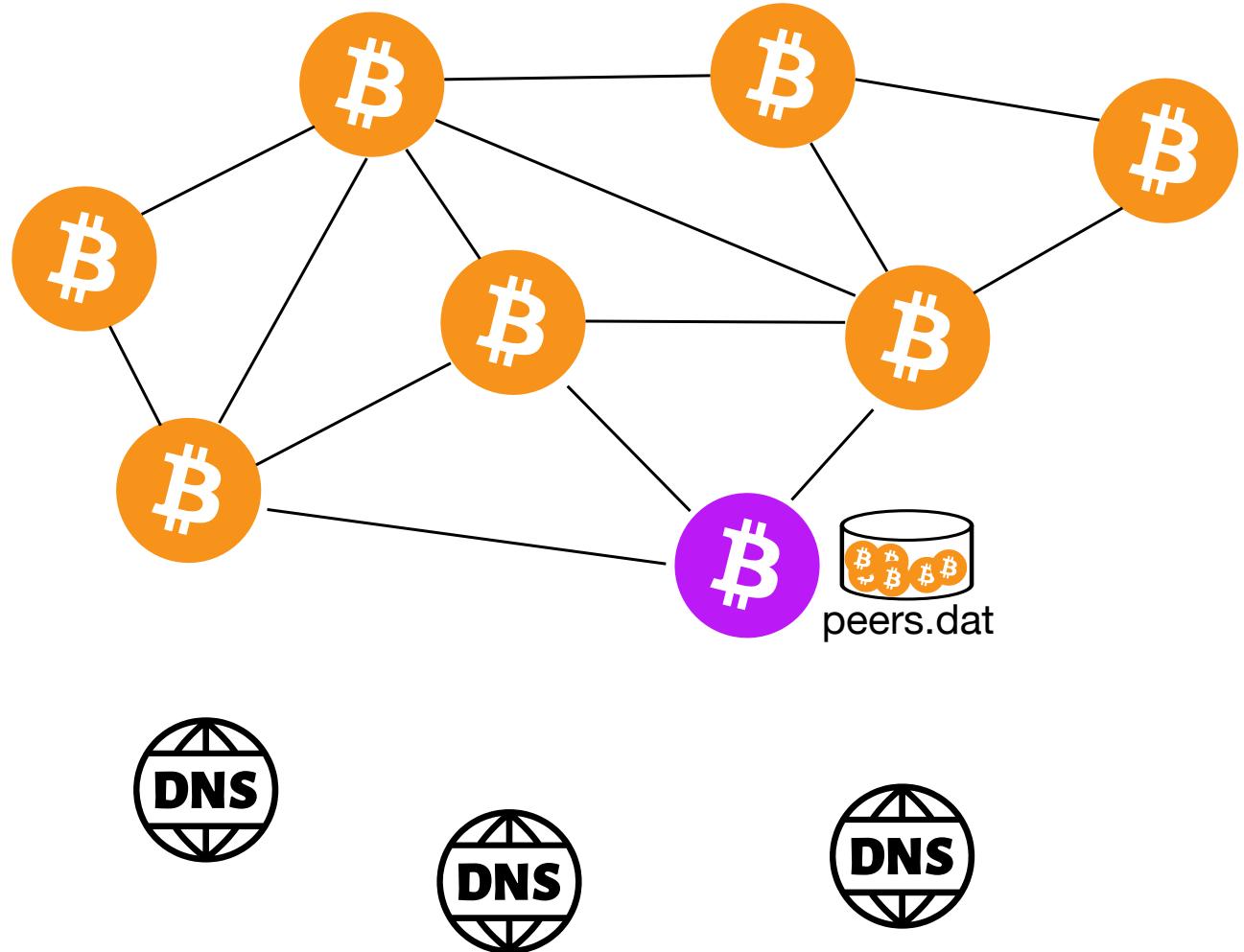
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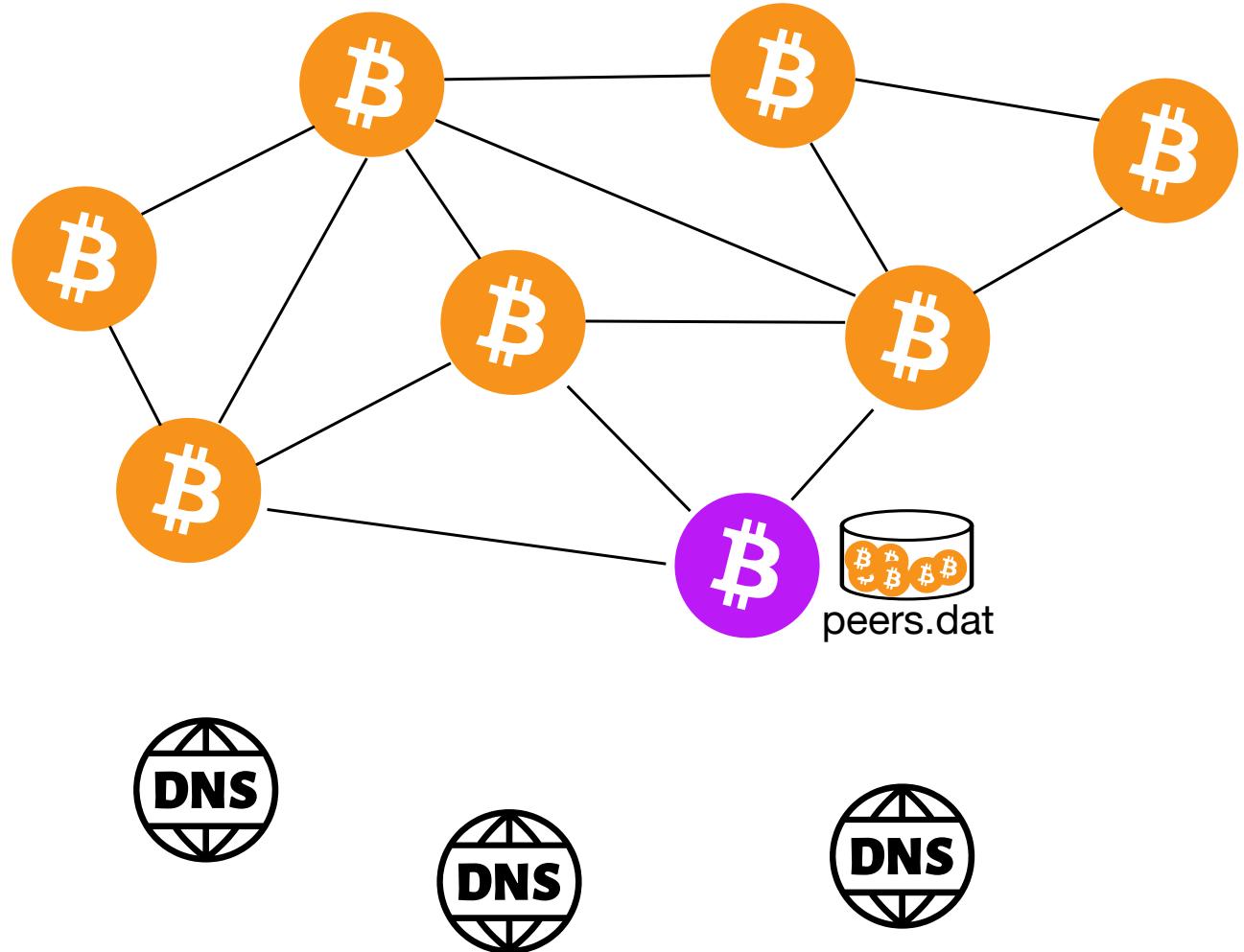
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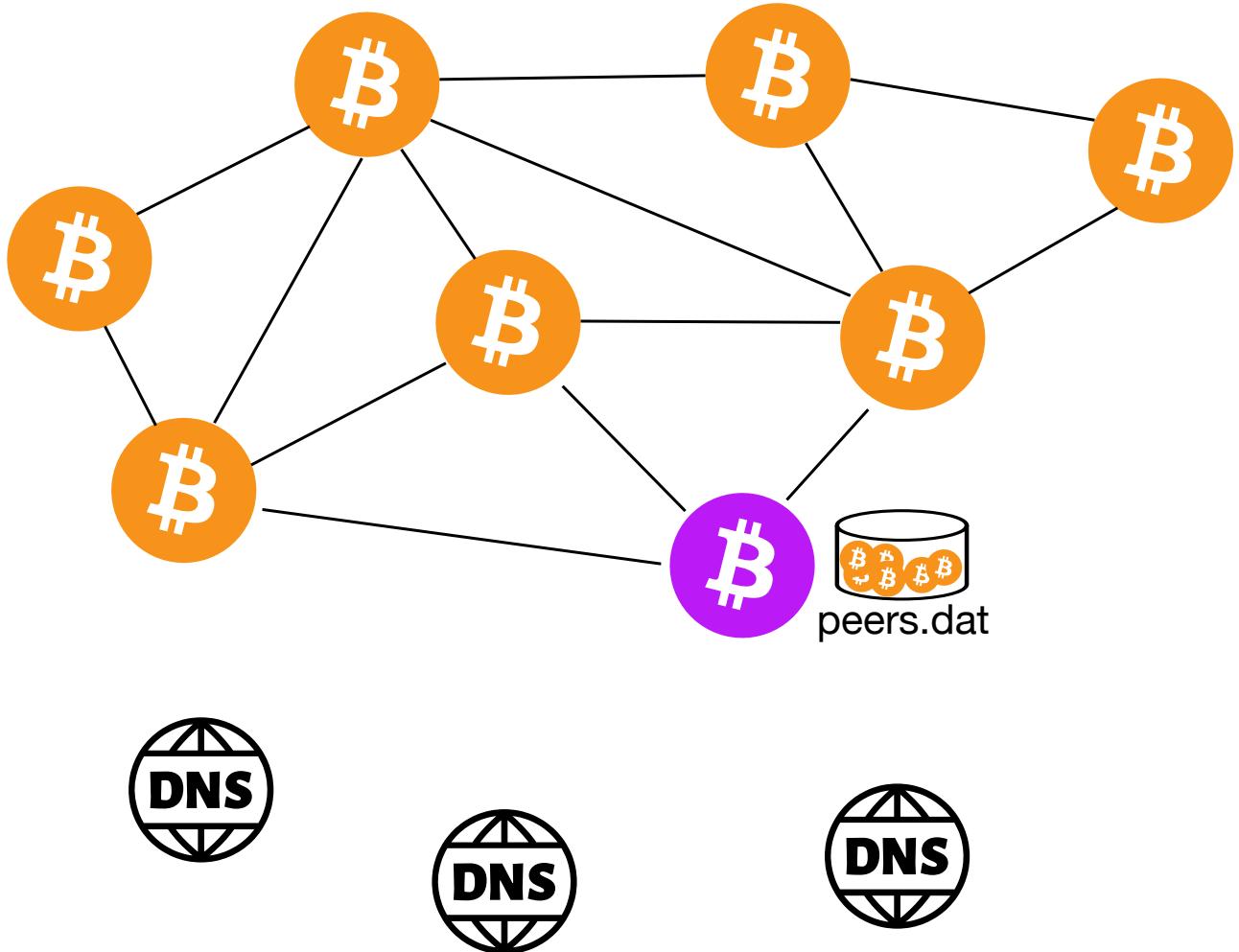
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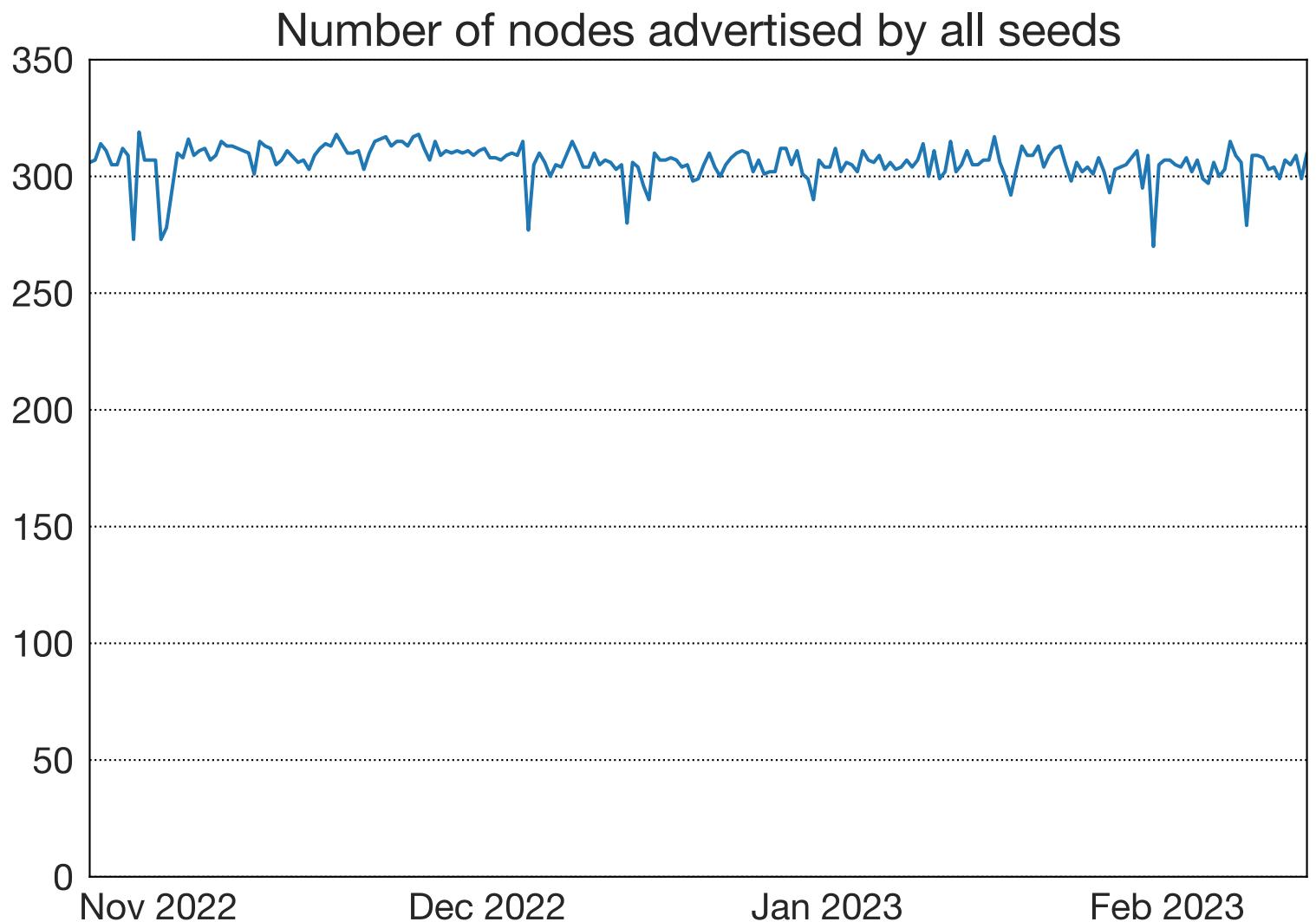
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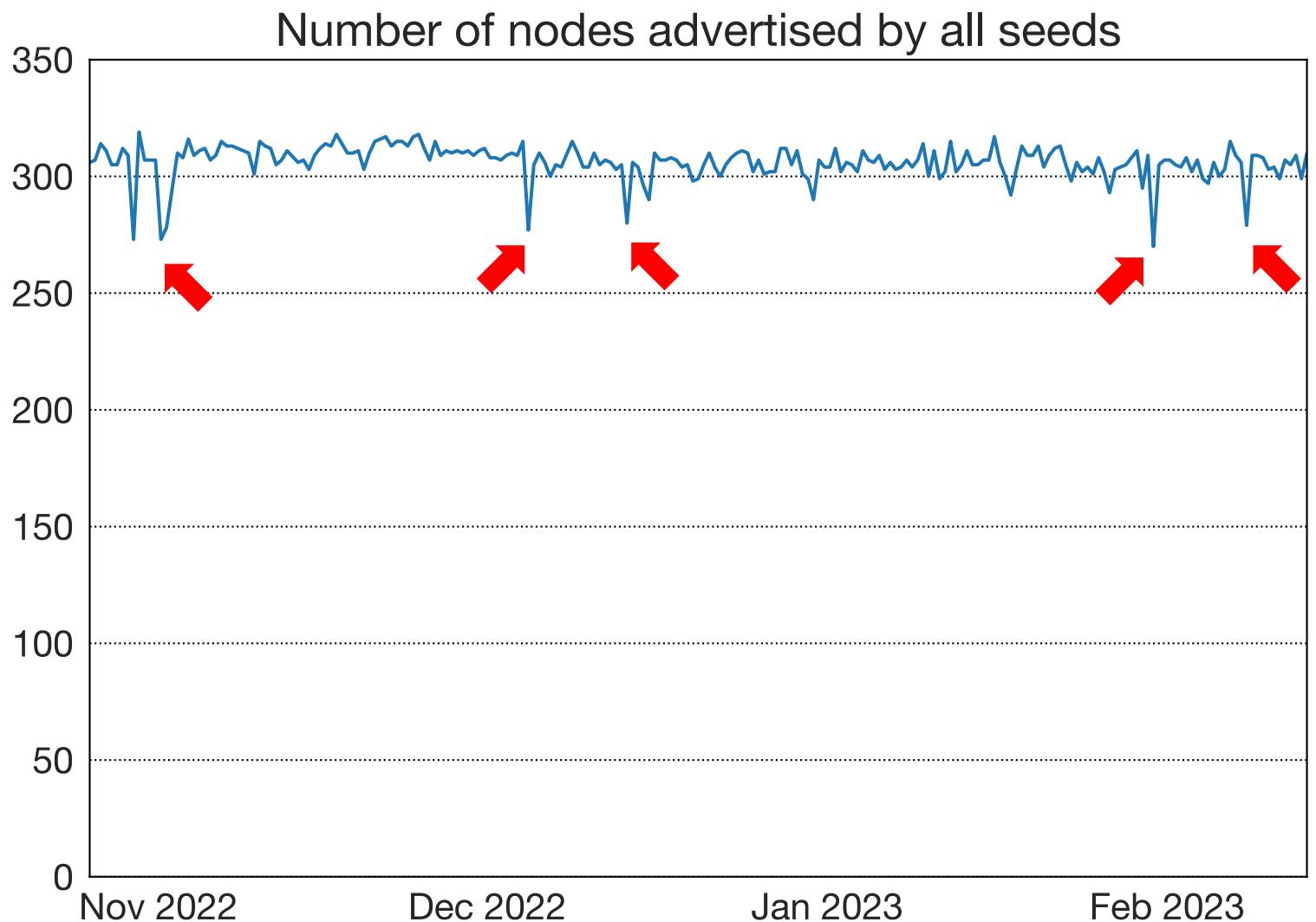
DNS seeds data

- DNS seed **uptime** and advertised **node count**



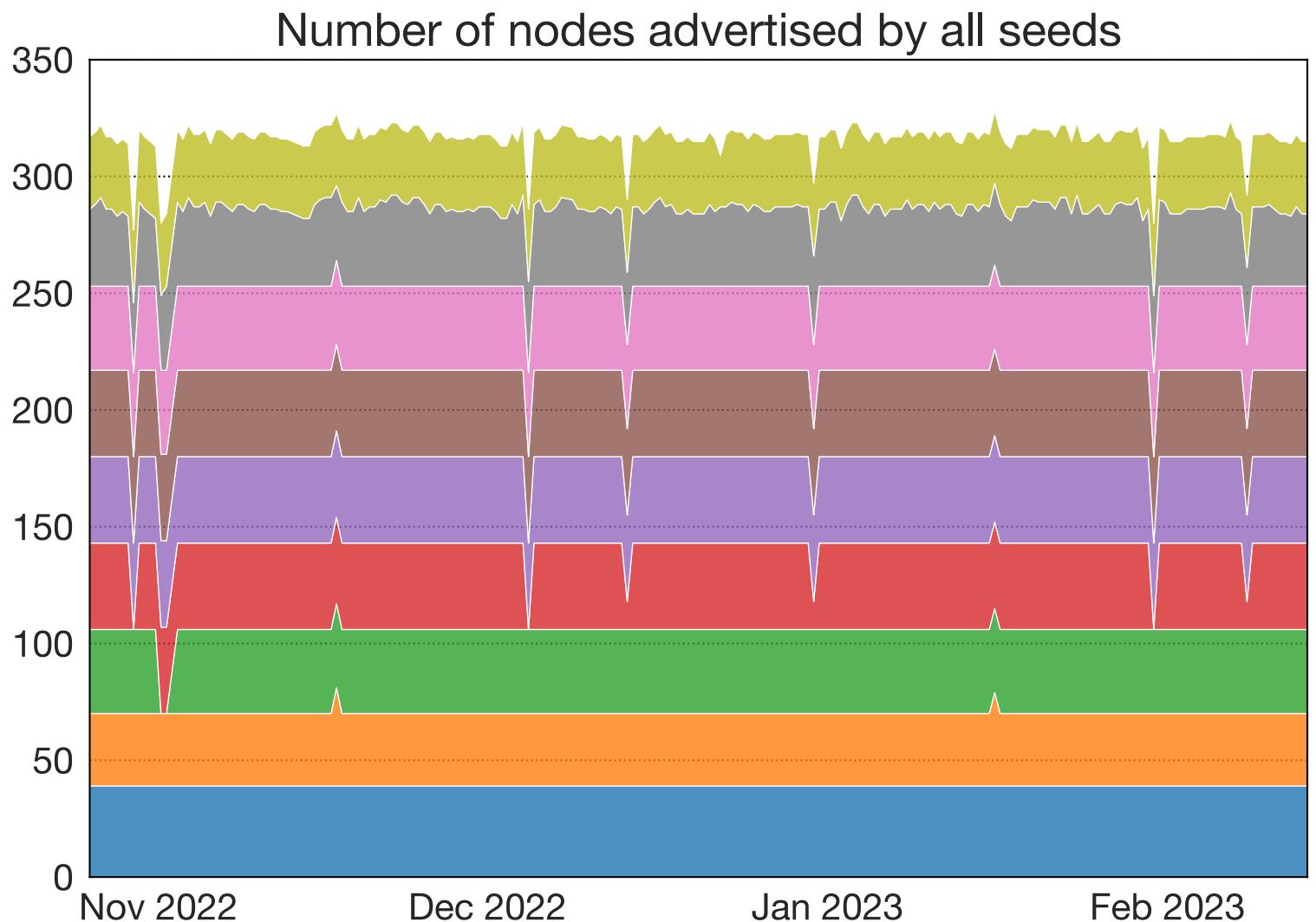
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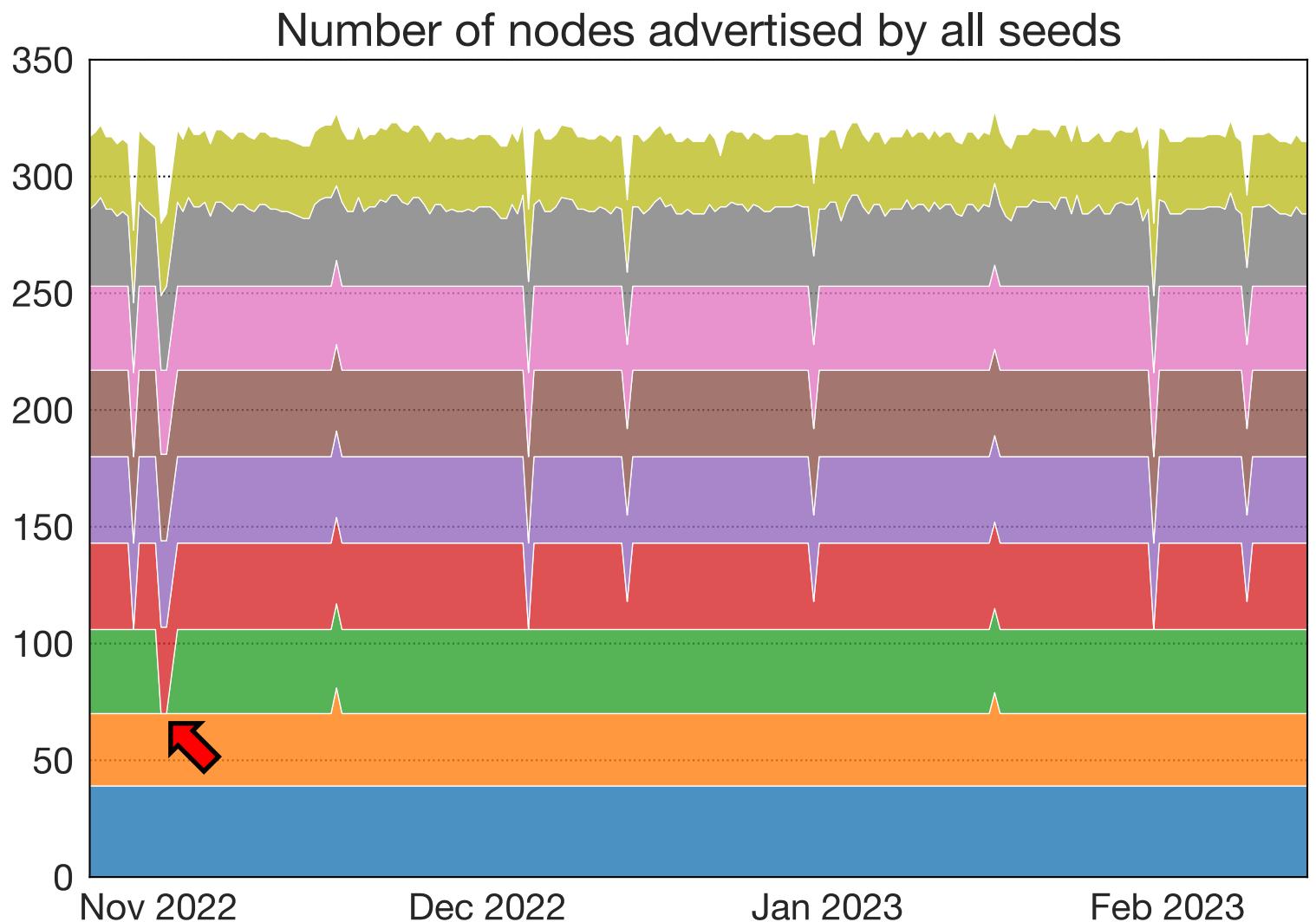
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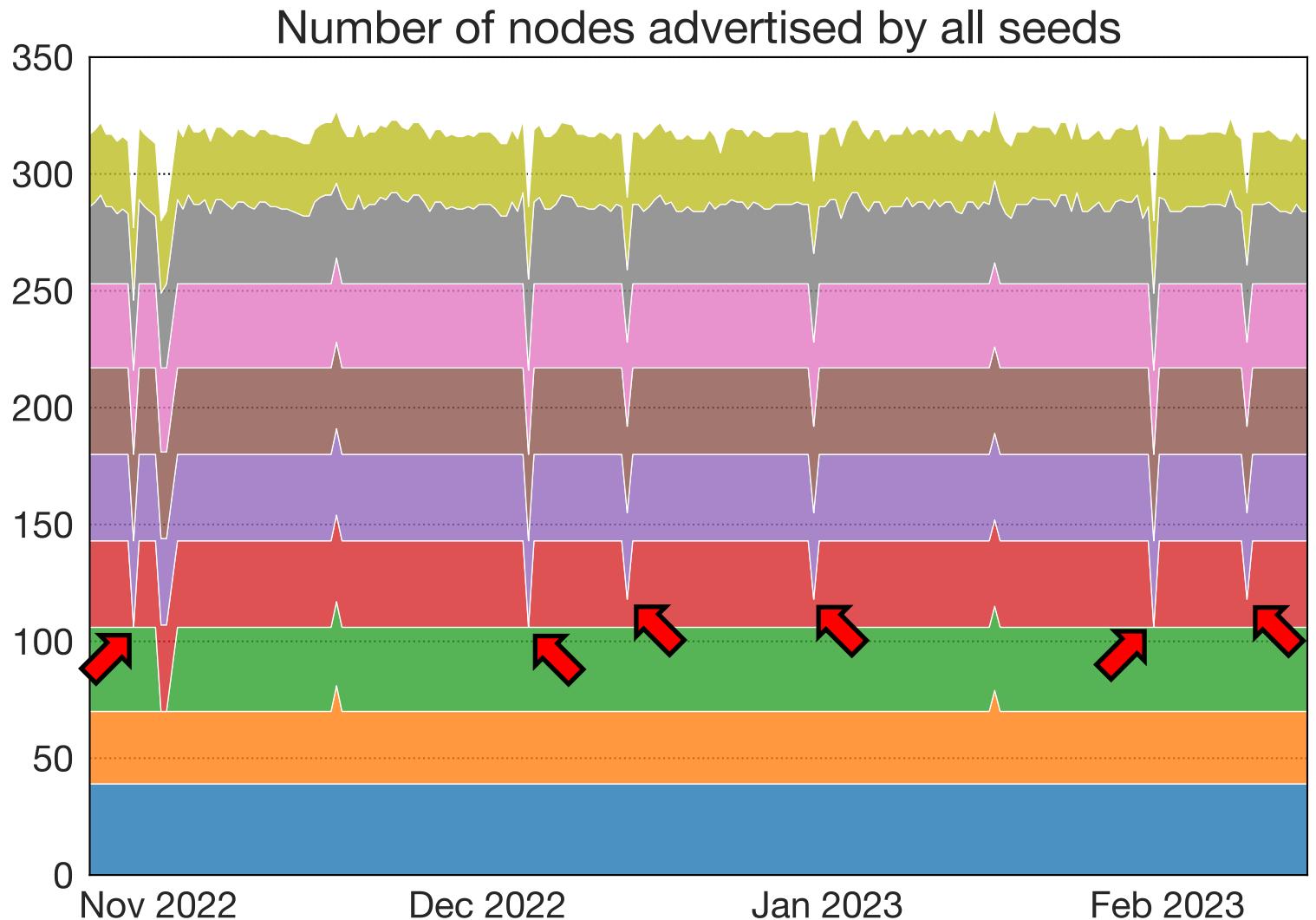
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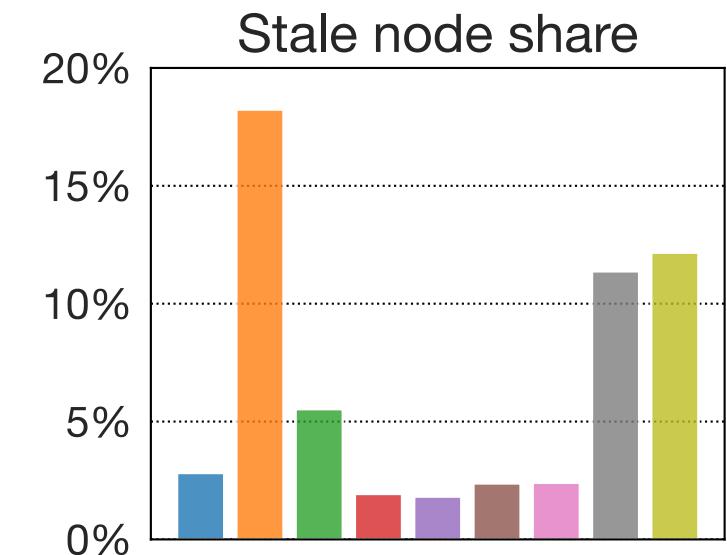
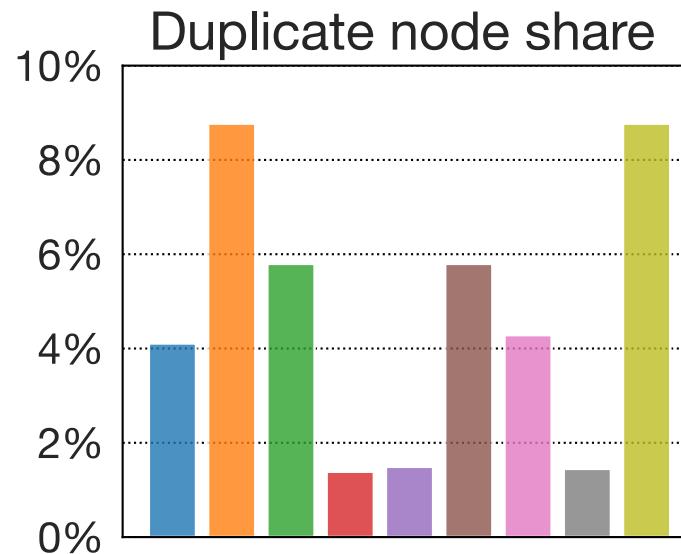
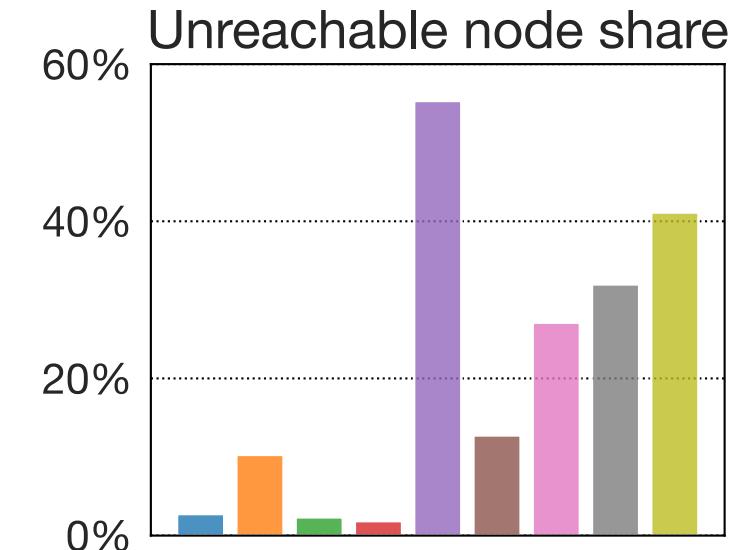
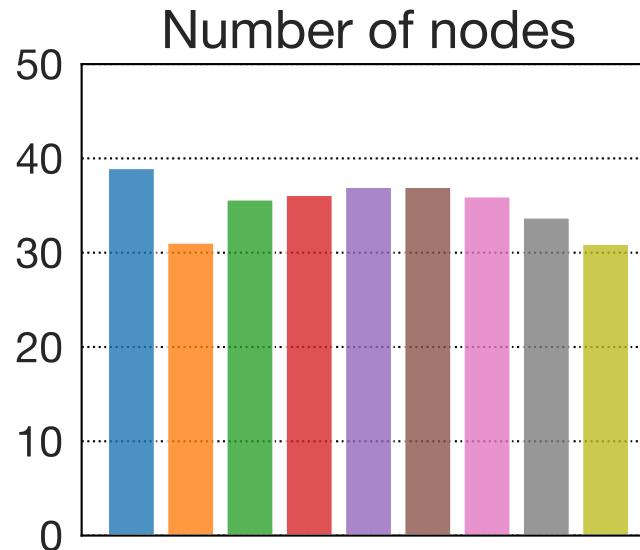
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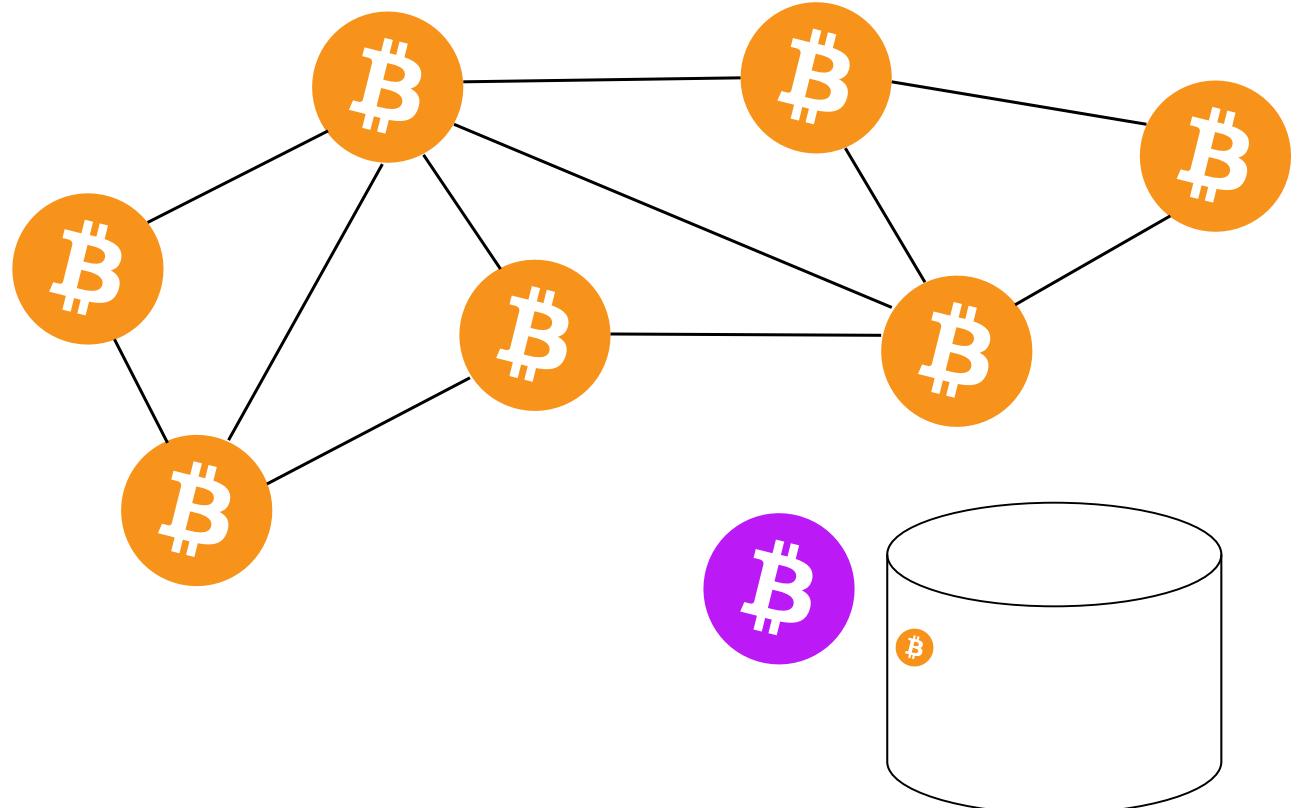
DNS seeds data

- DNS seed **uptime** and advertised **node count**
- **Availability** of advertised nodes
- **Uniqueness** of advertised nodes
- **Variability** of advertised nodes



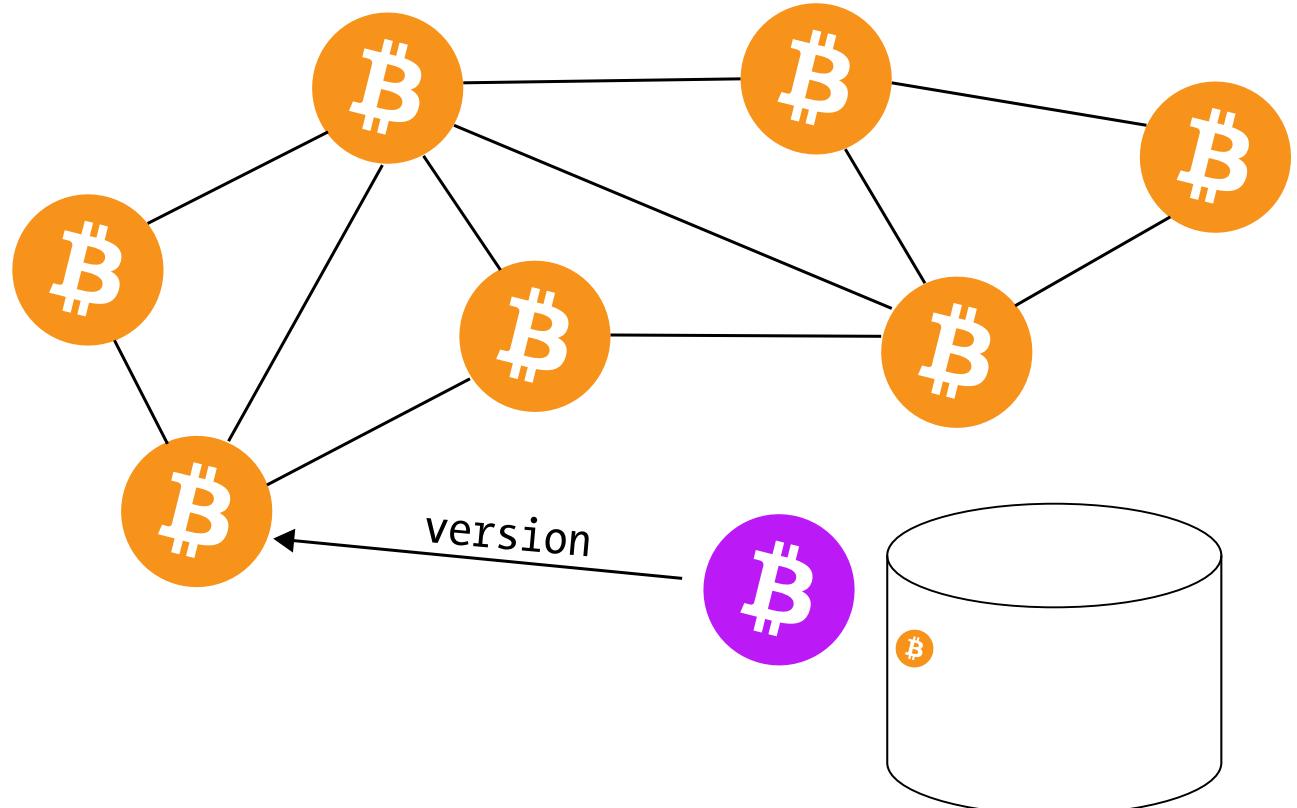
Crawling the P2P network

- Methodology and collected data



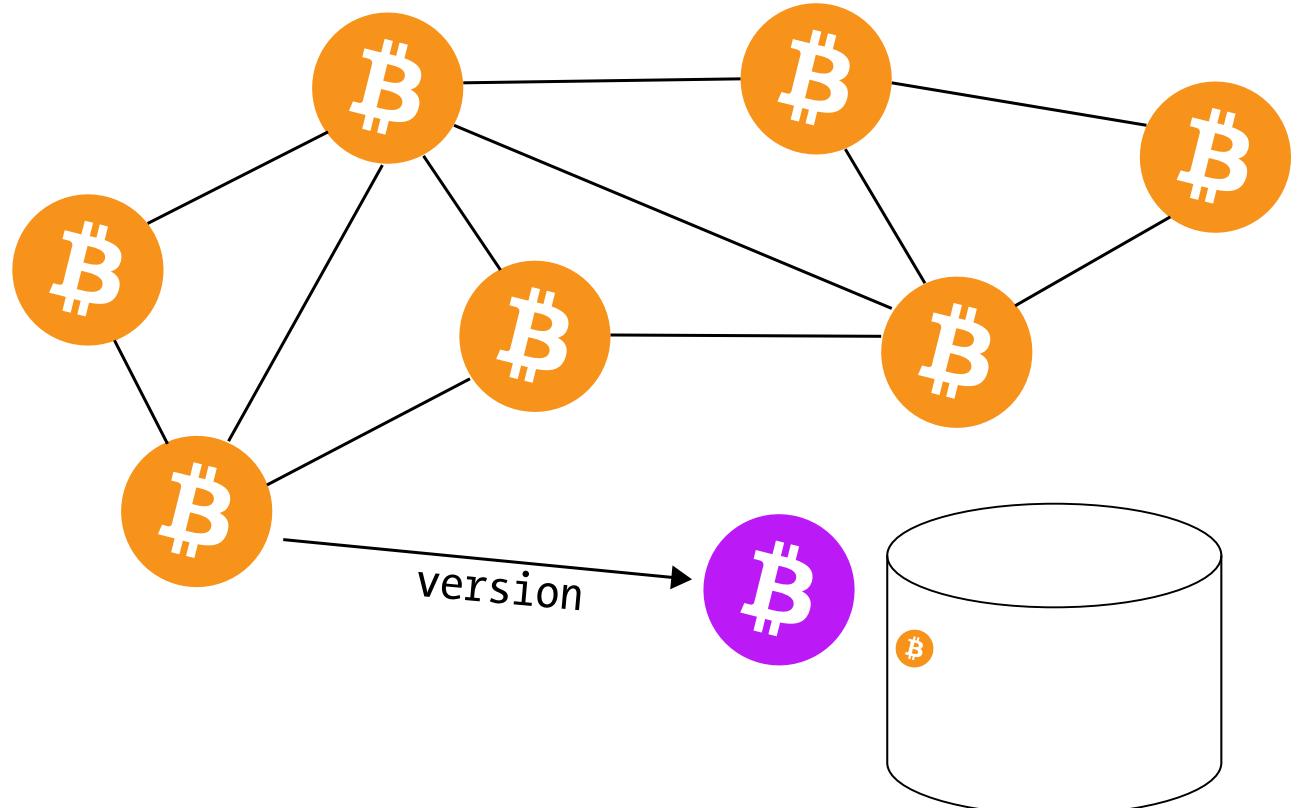
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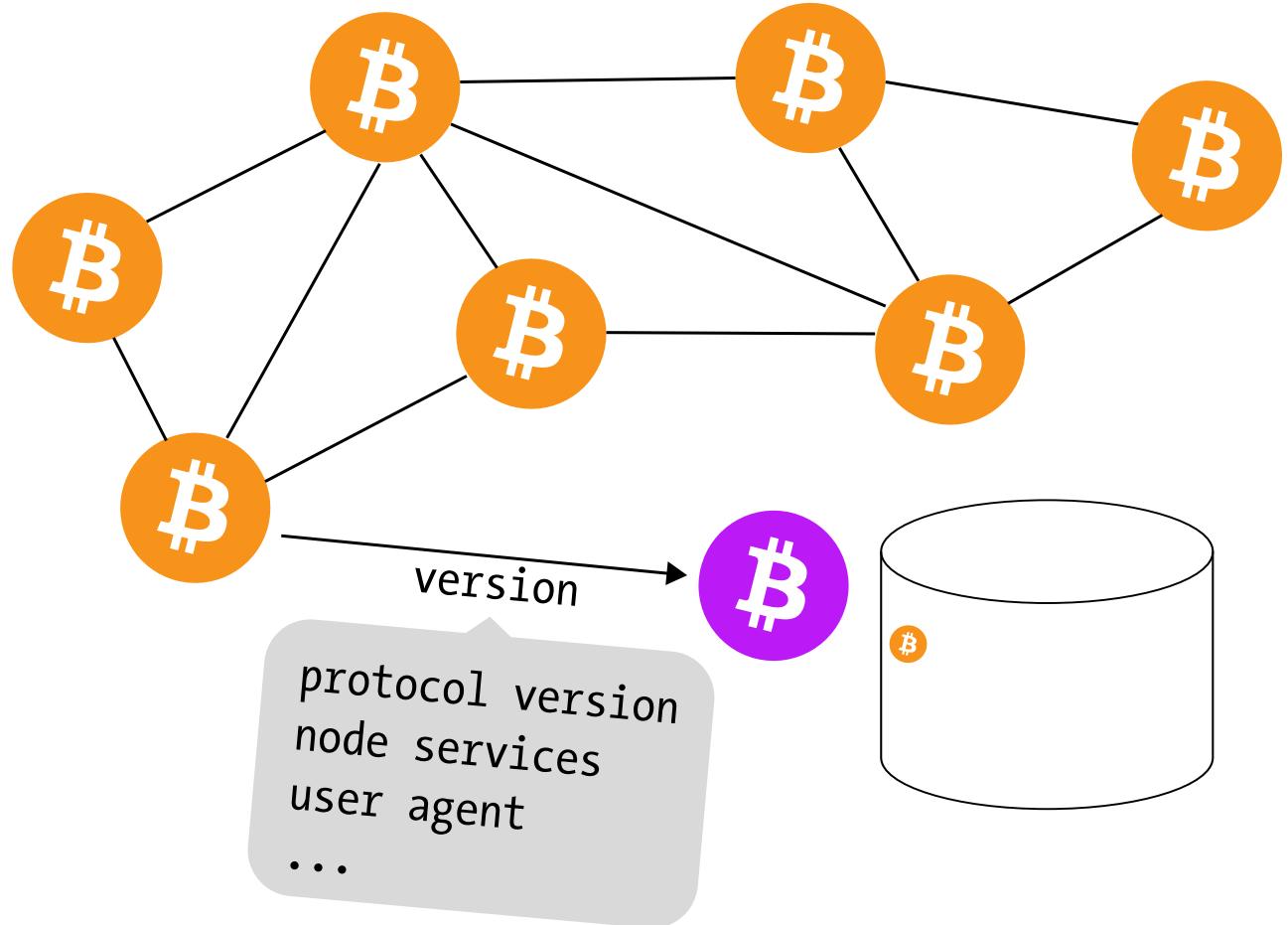
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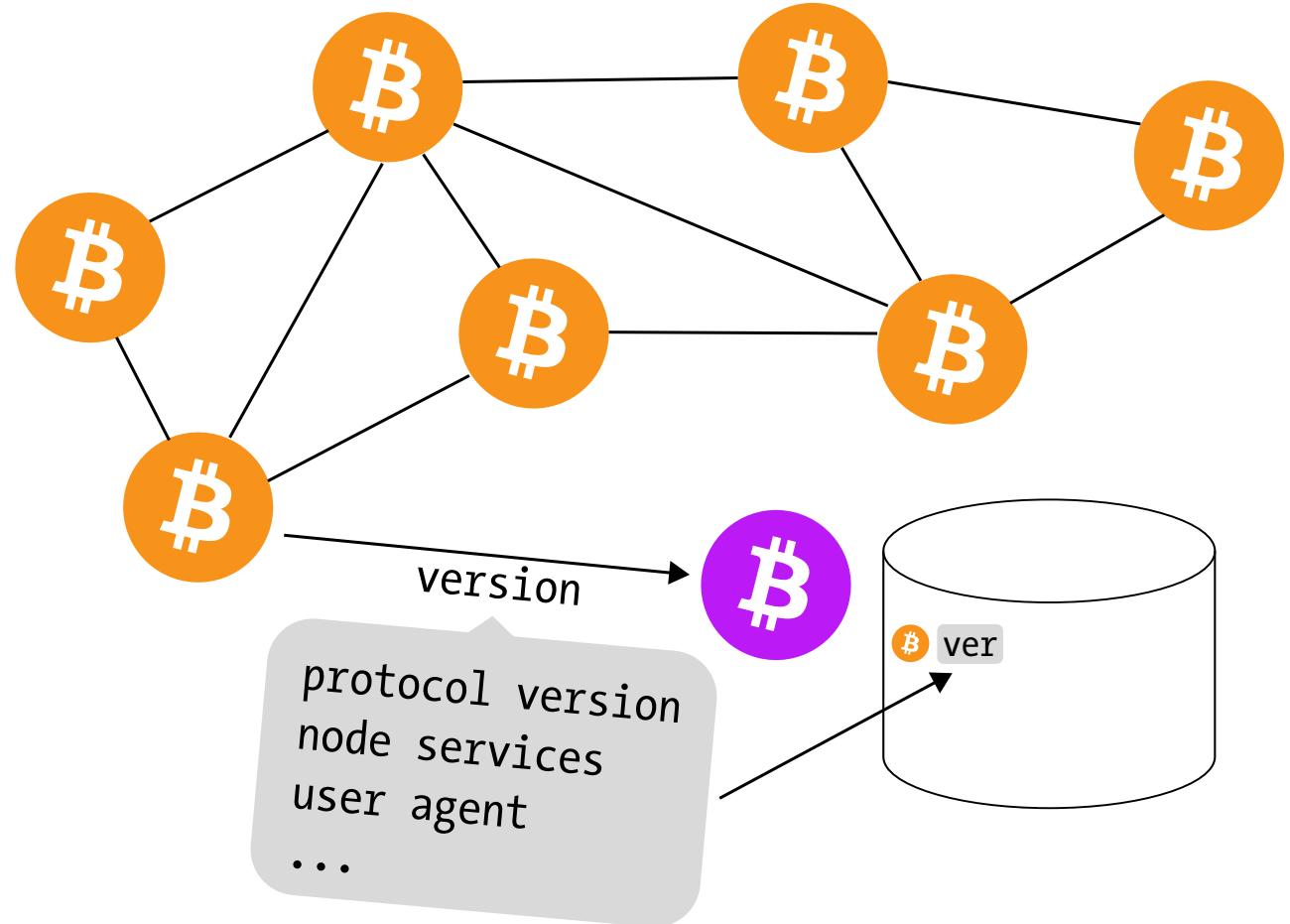
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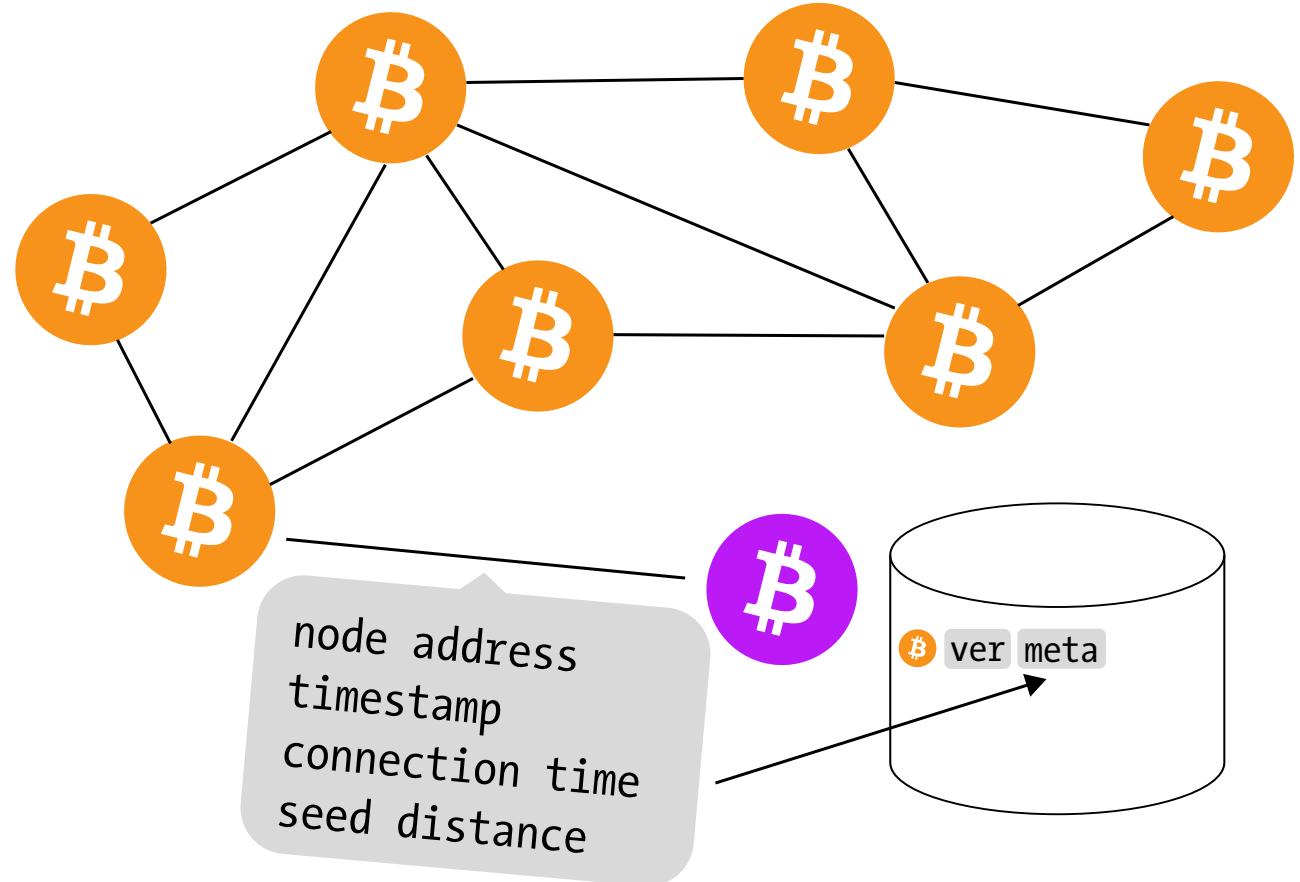
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- Methodology and collected data
 - Handshake



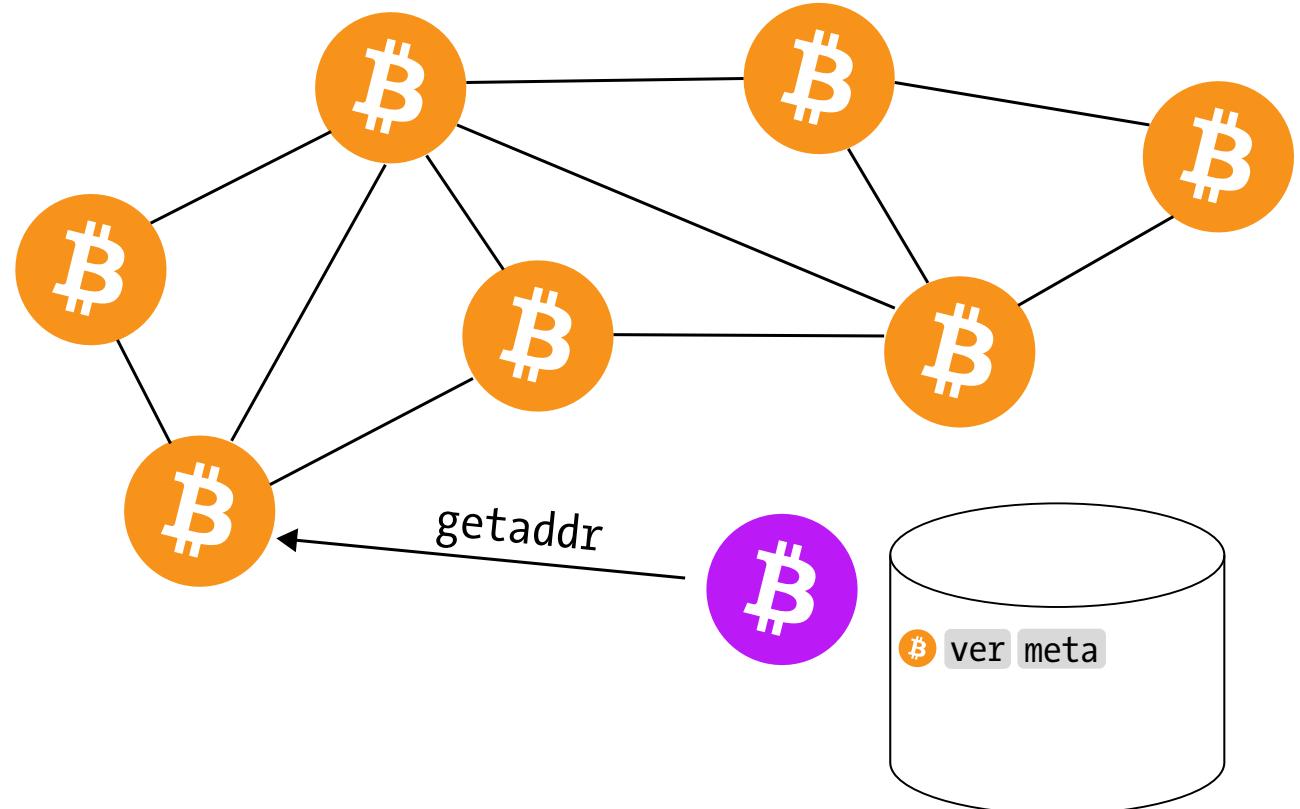
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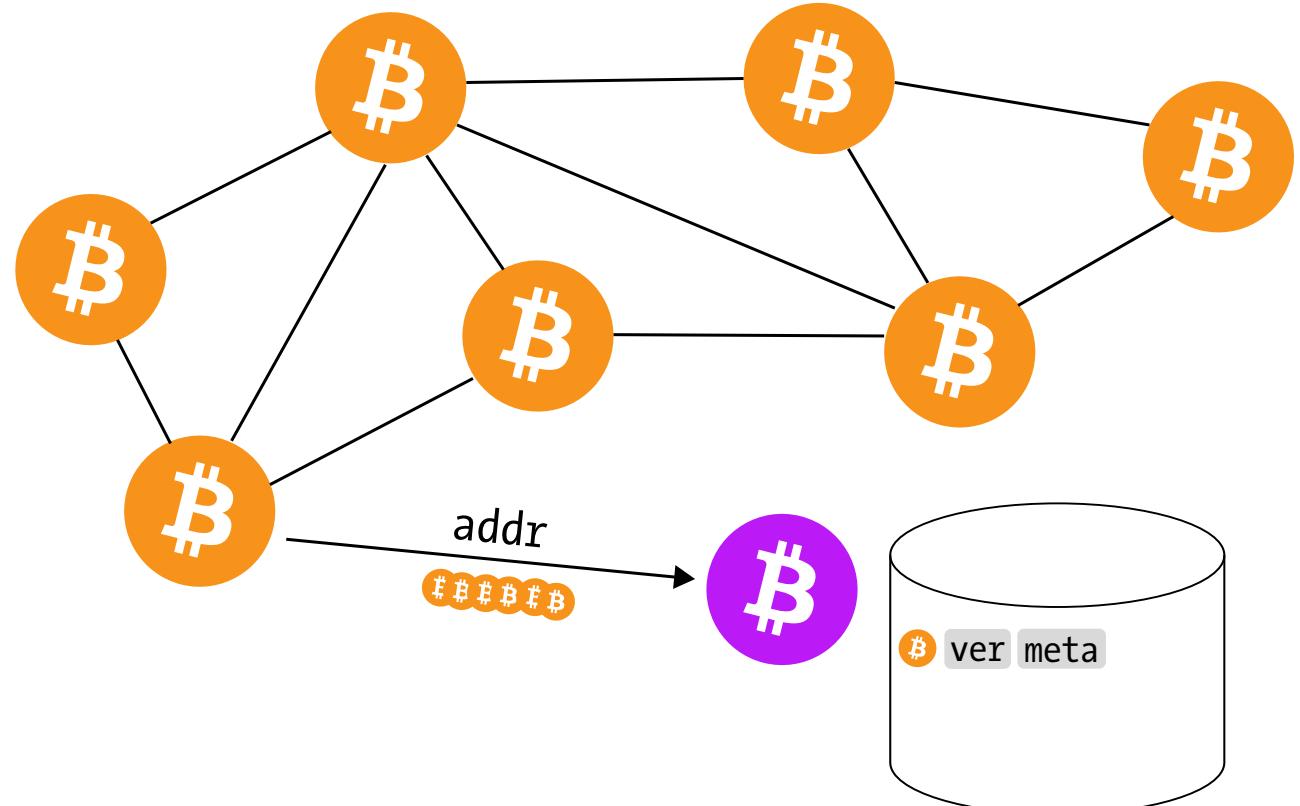
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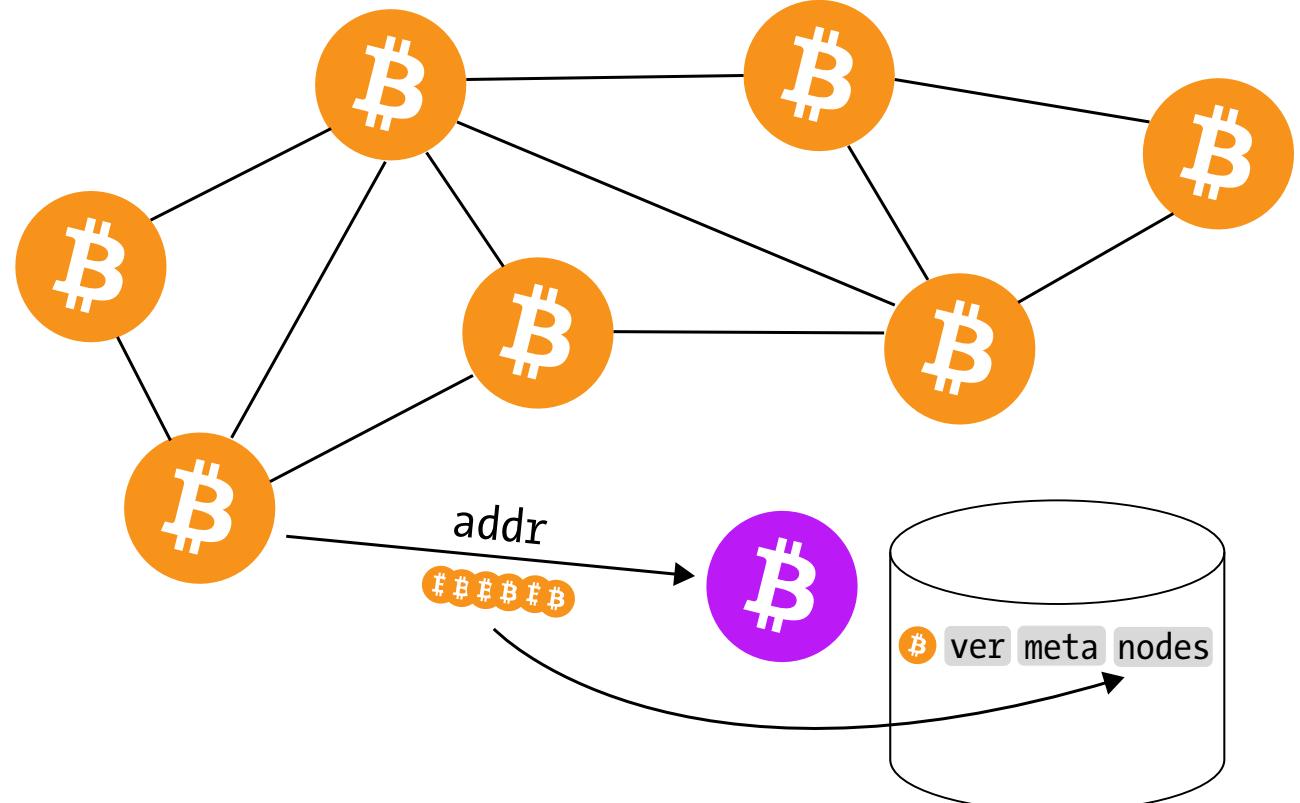
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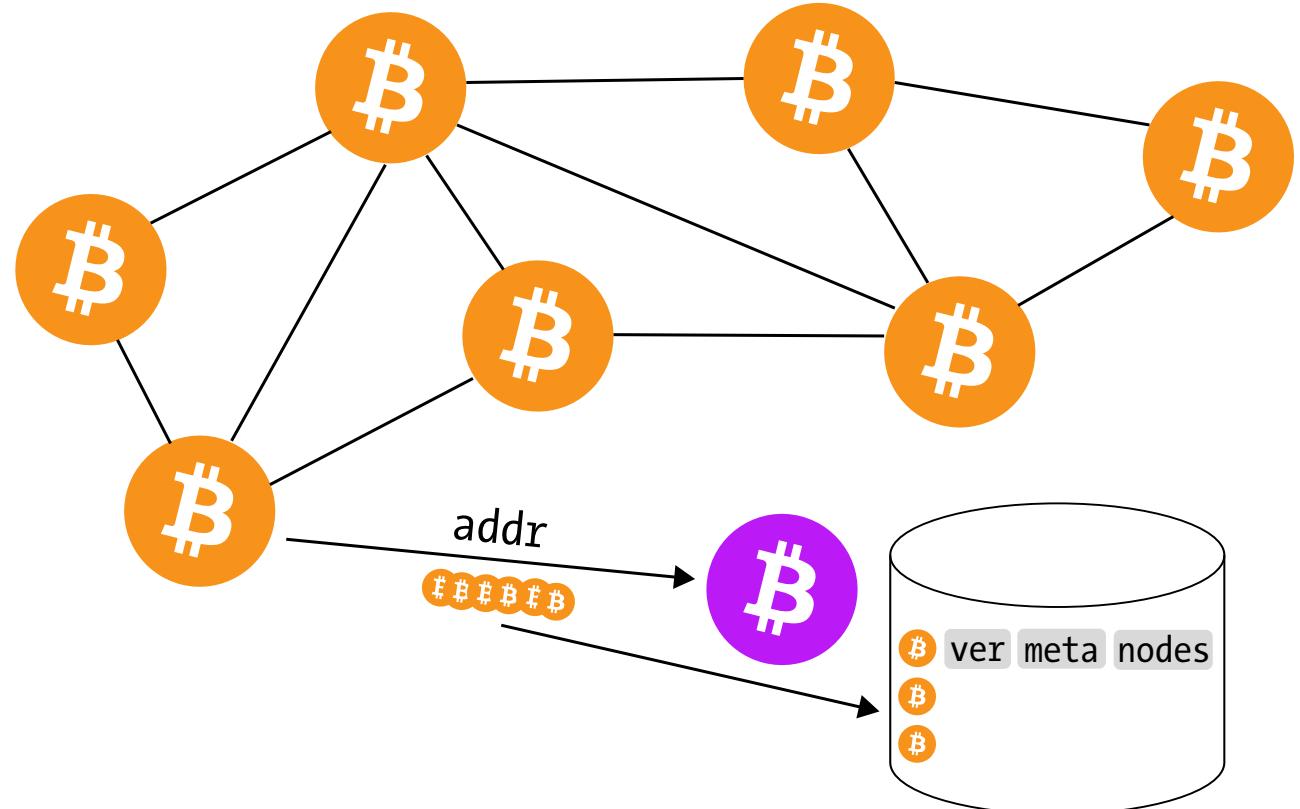
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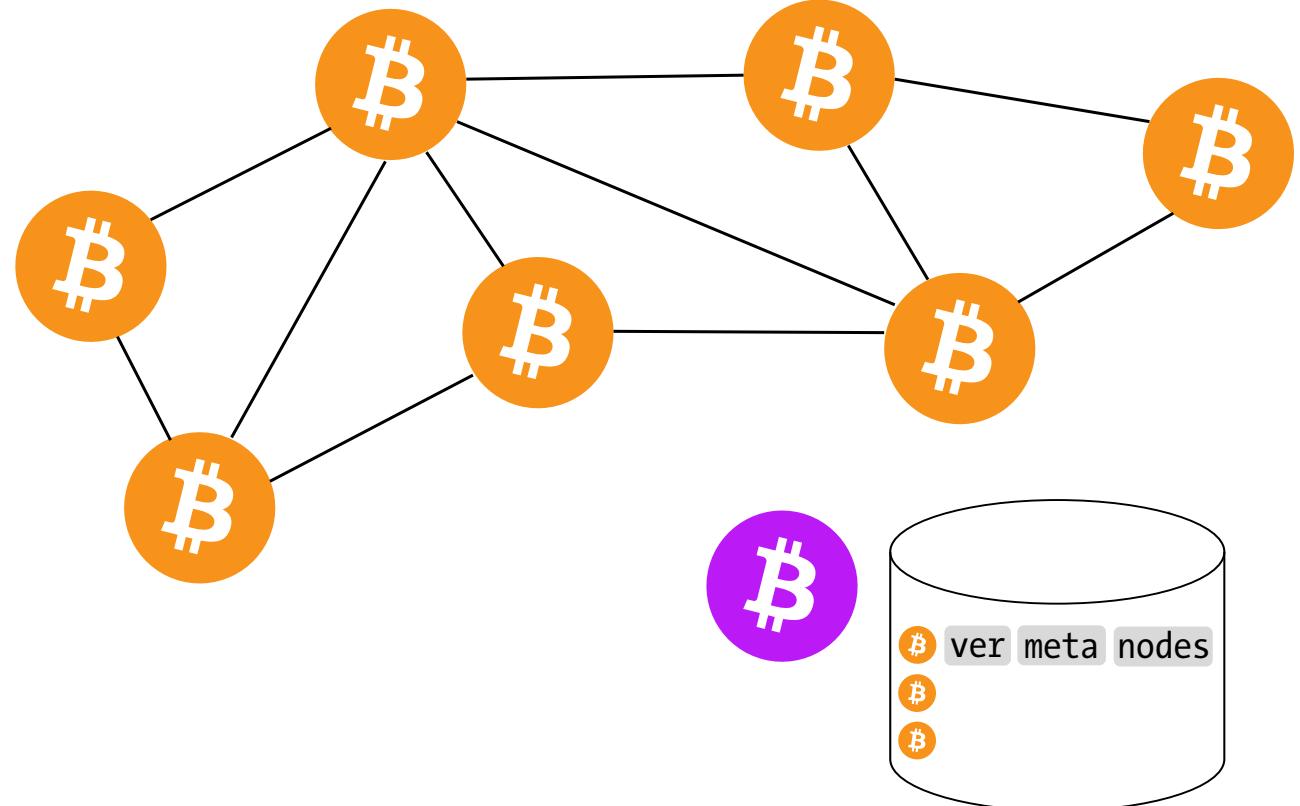
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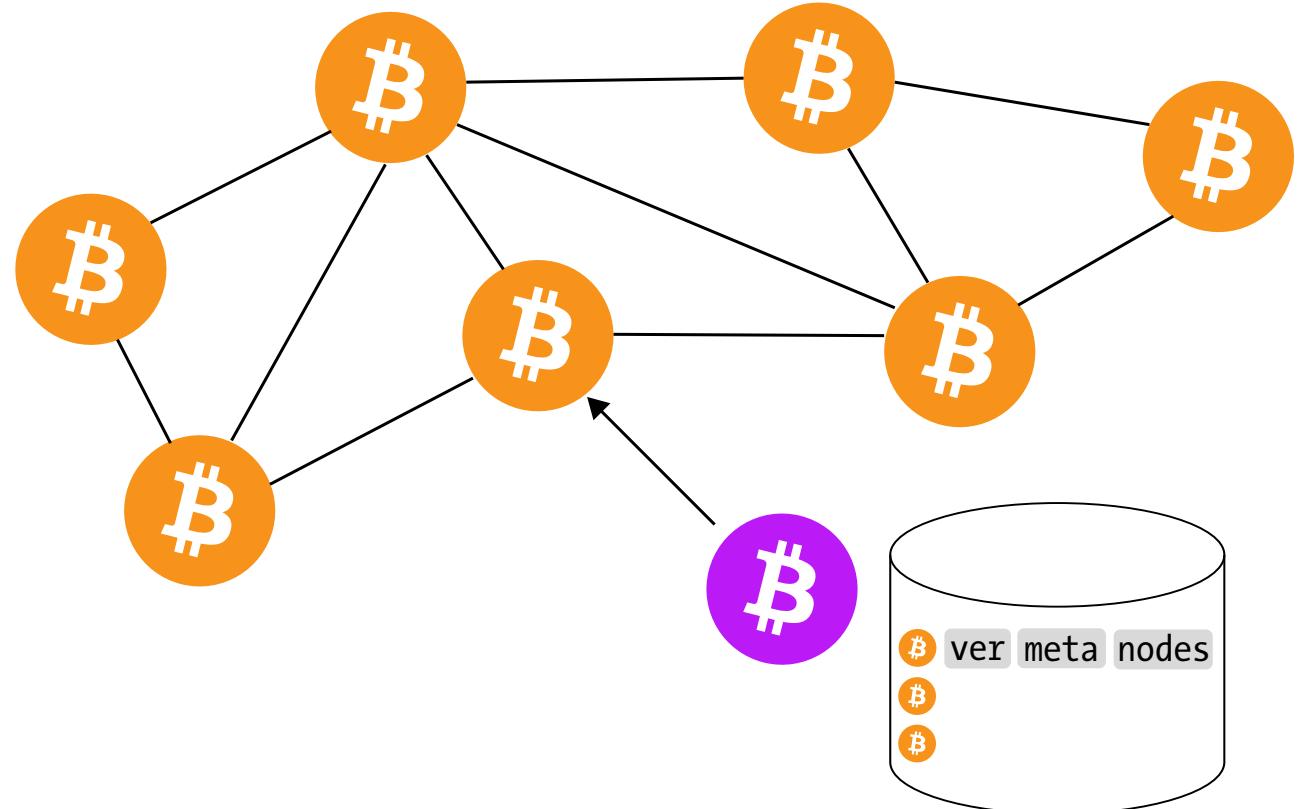
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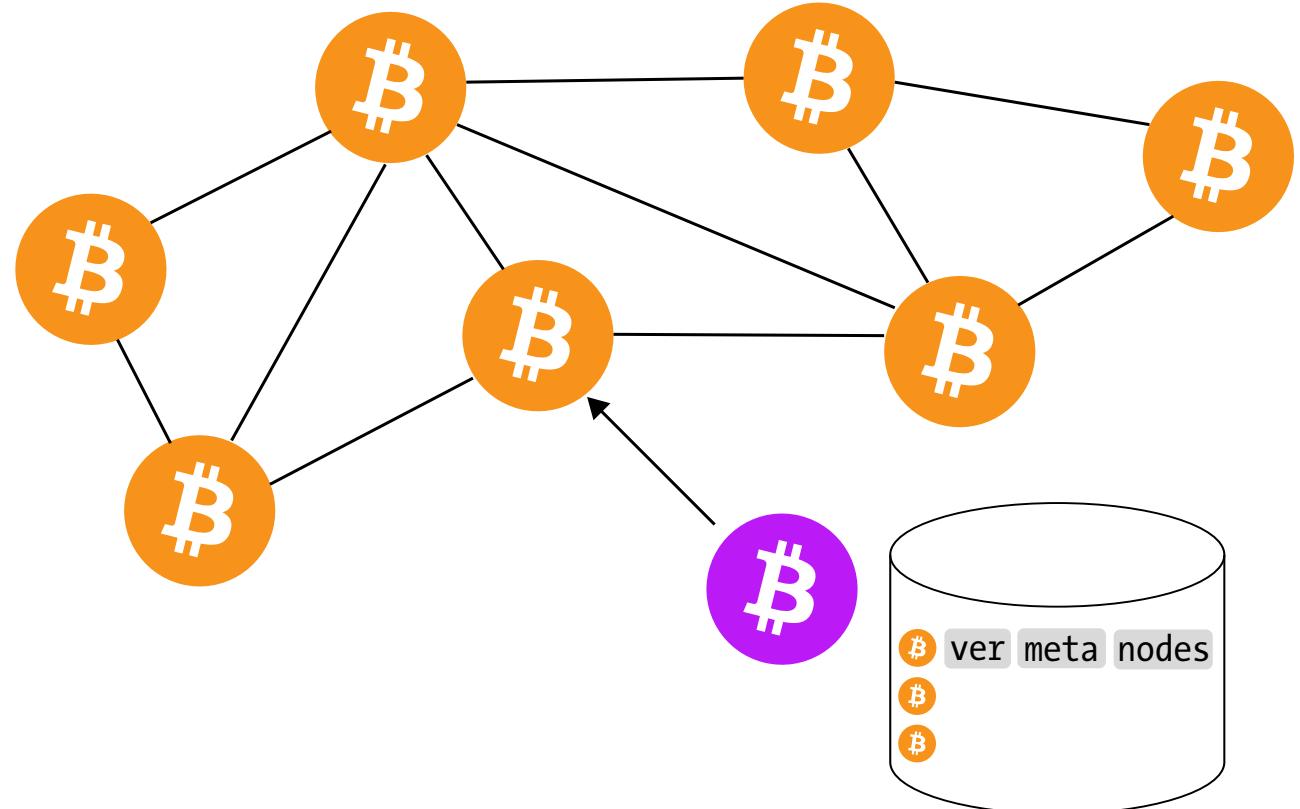
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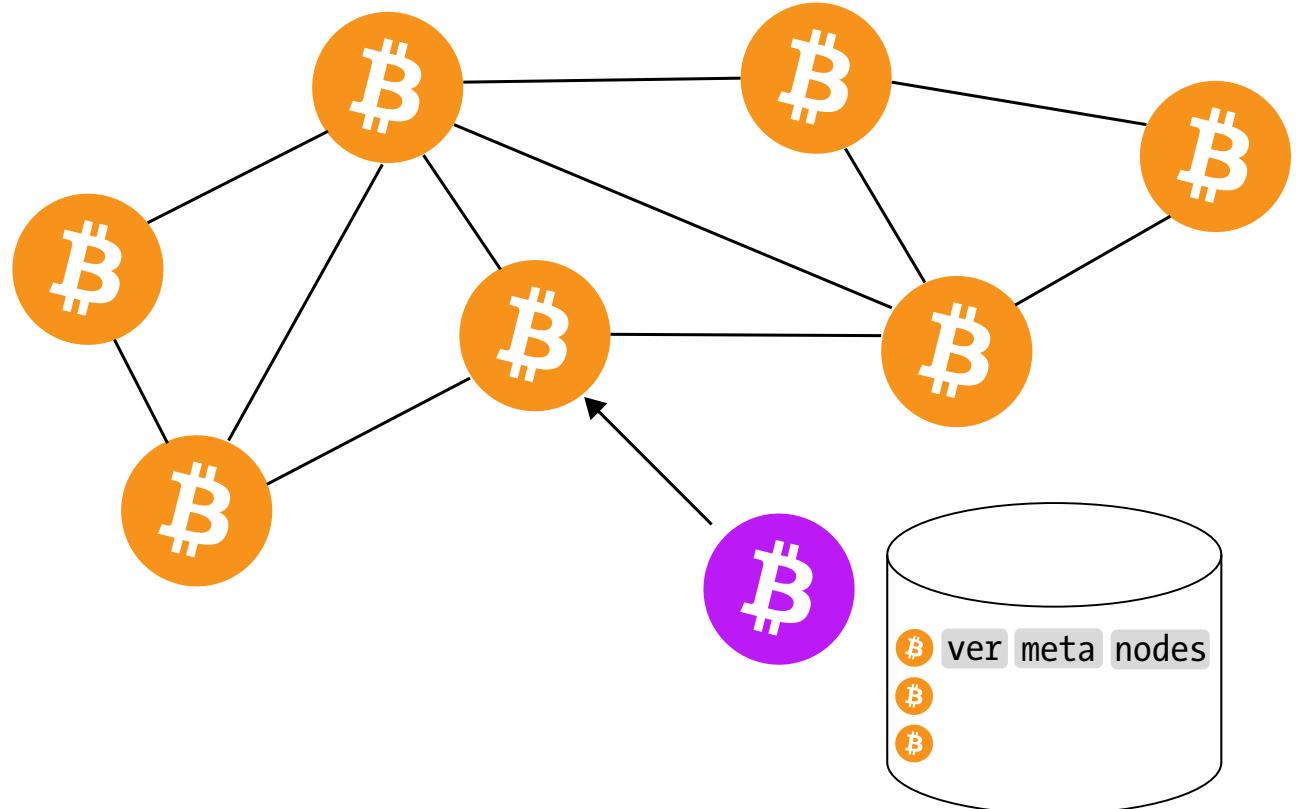
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- Why?



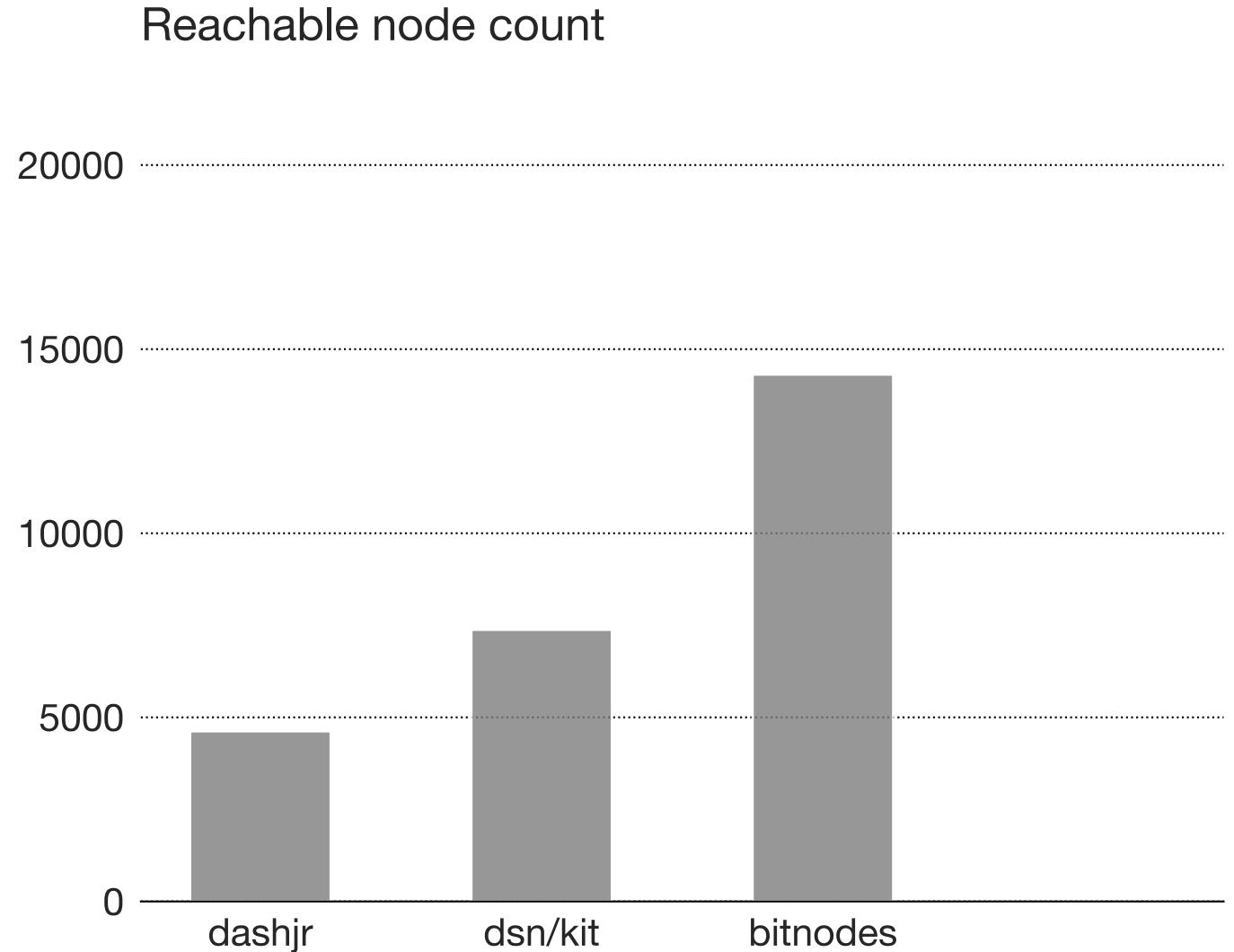
Crawling the P2P network

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- Why?
 - Some interesting data not available
 - Some insights require raw data
 - Open source data set and methodology
 - Reliability



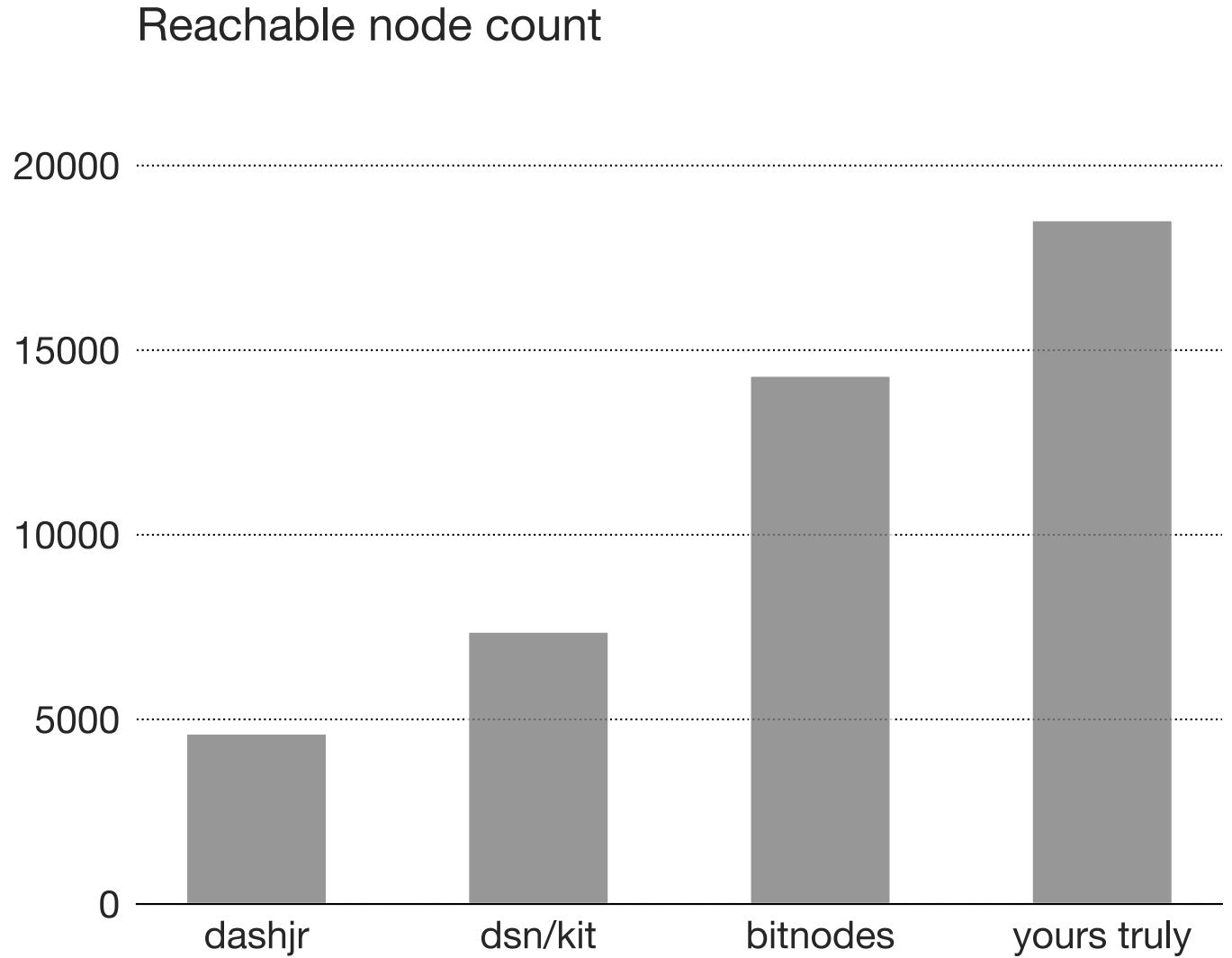
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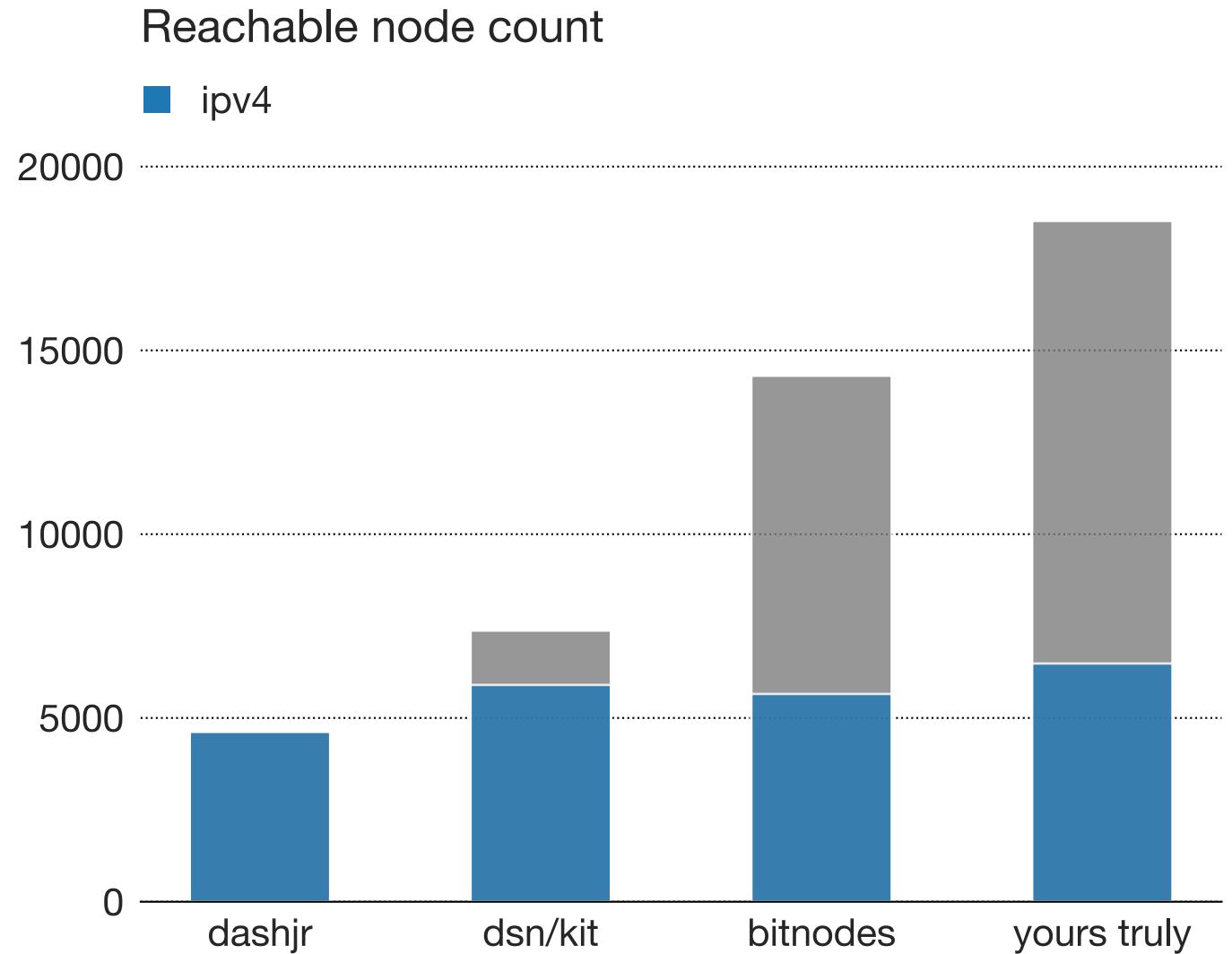
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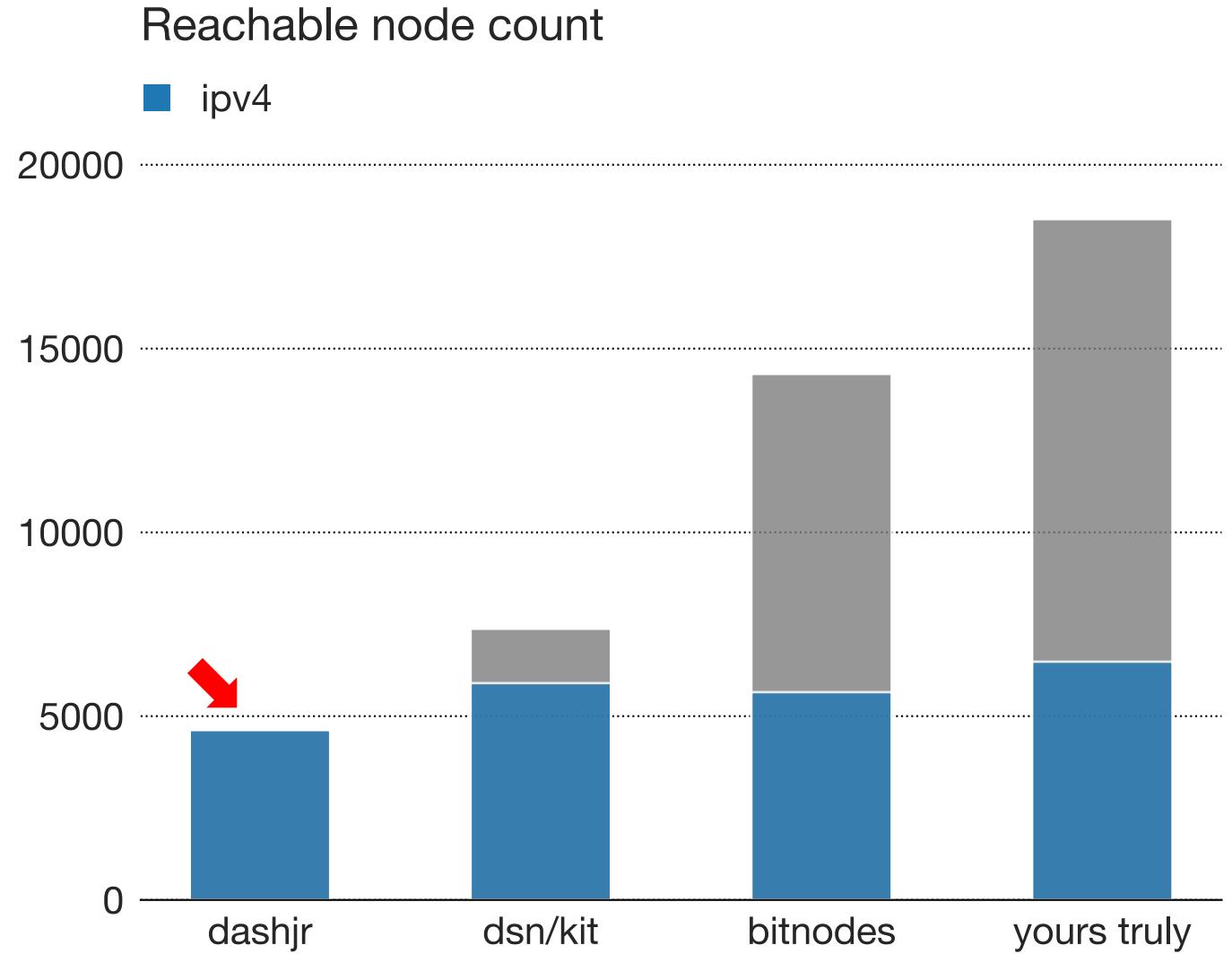
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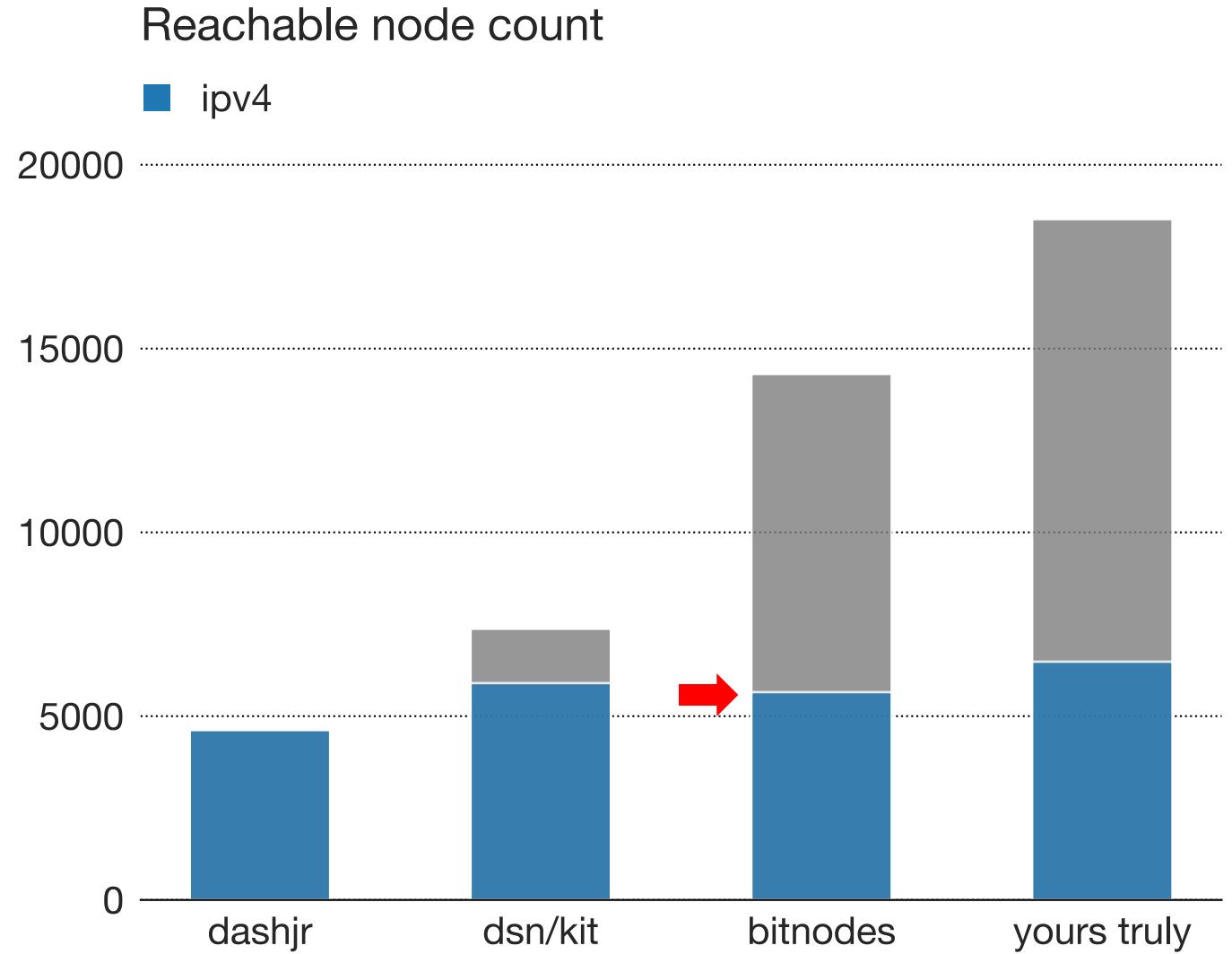
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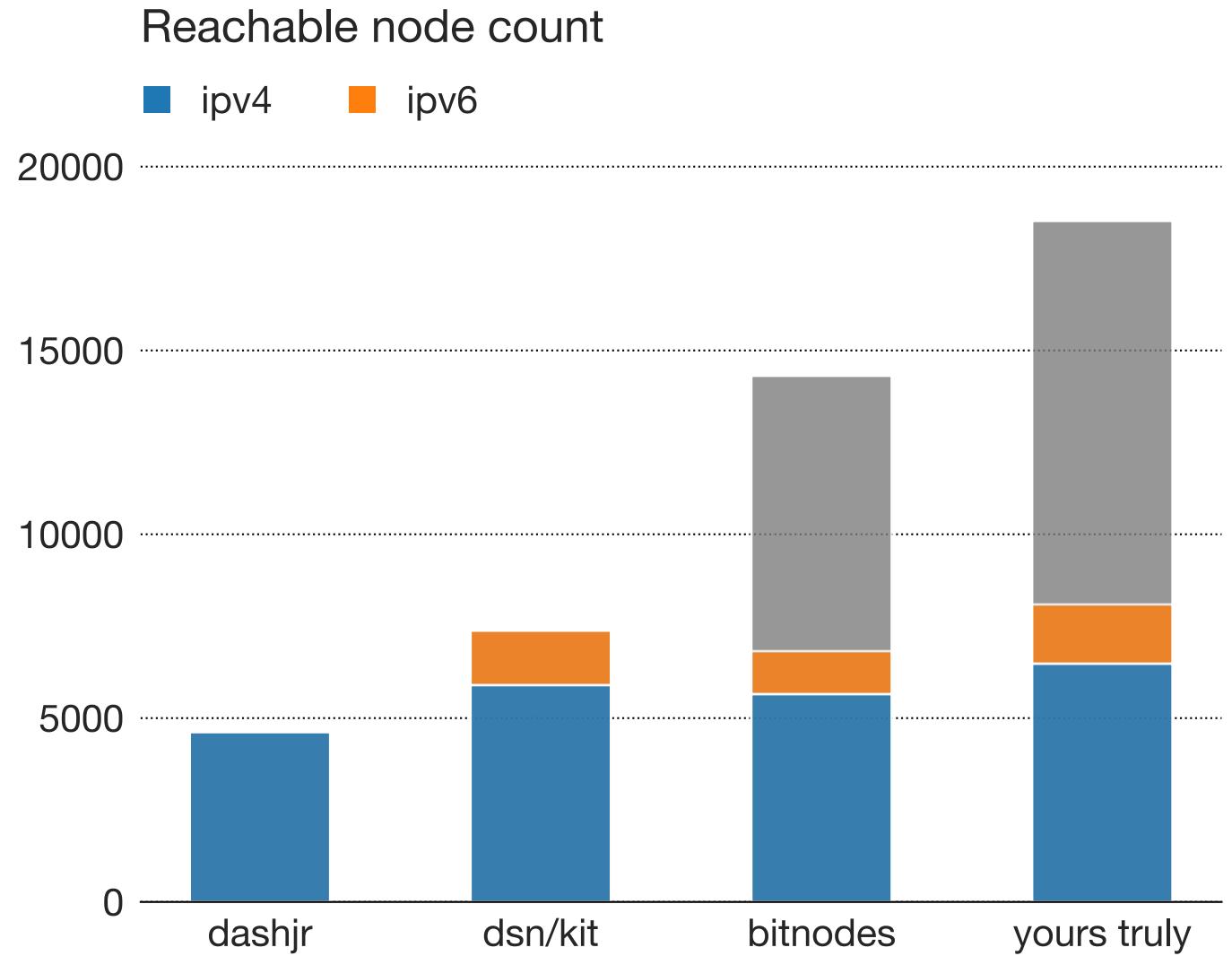
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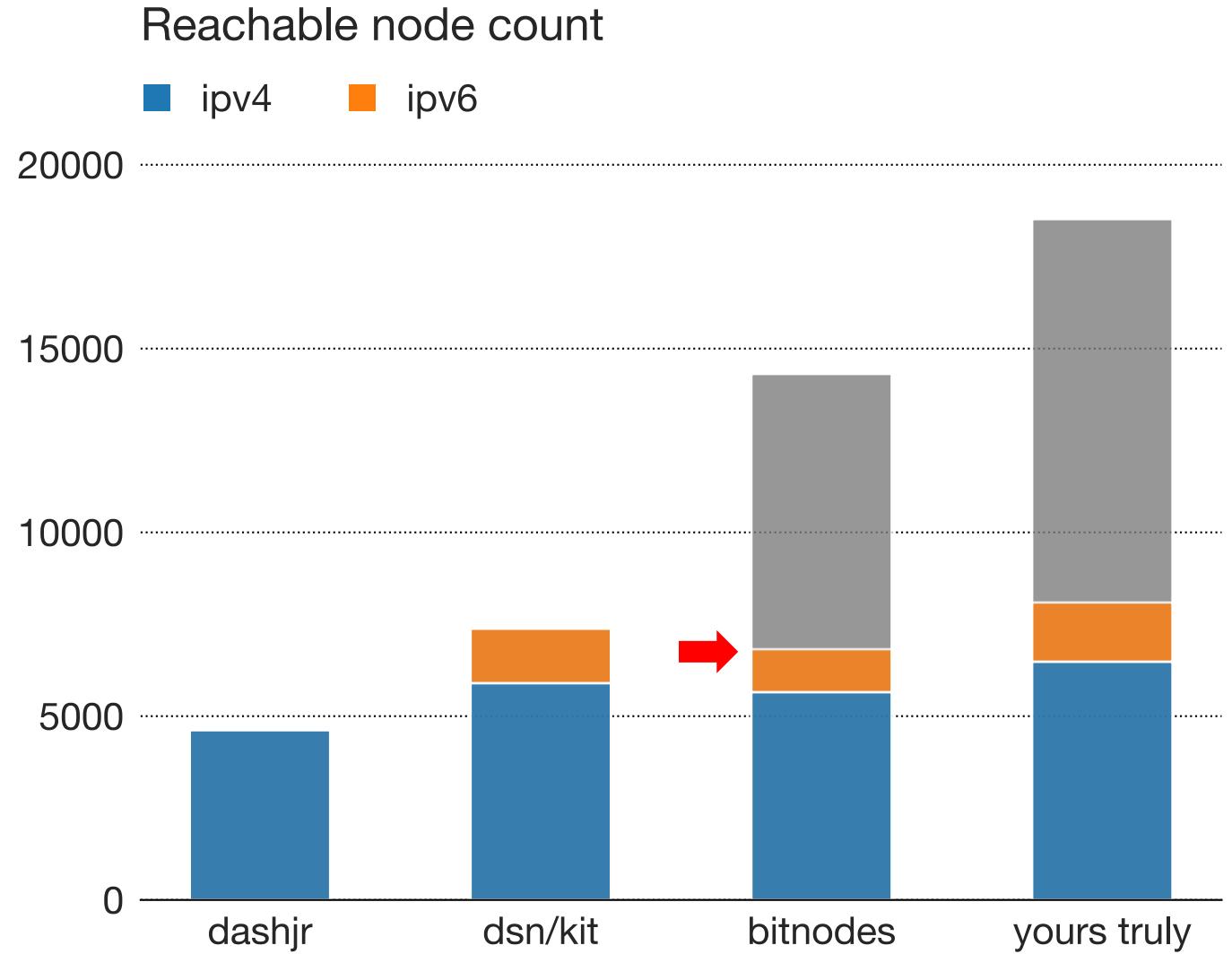
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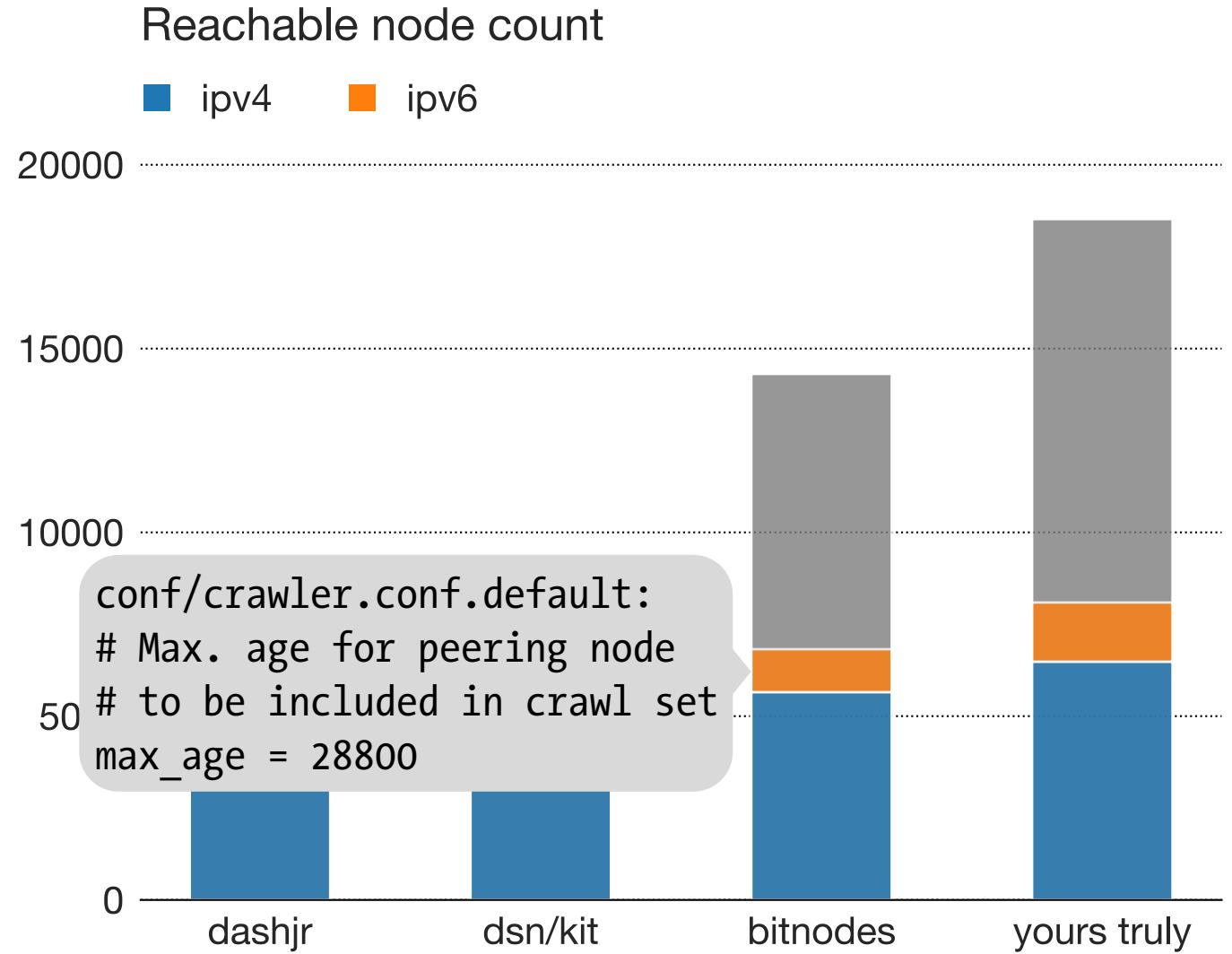
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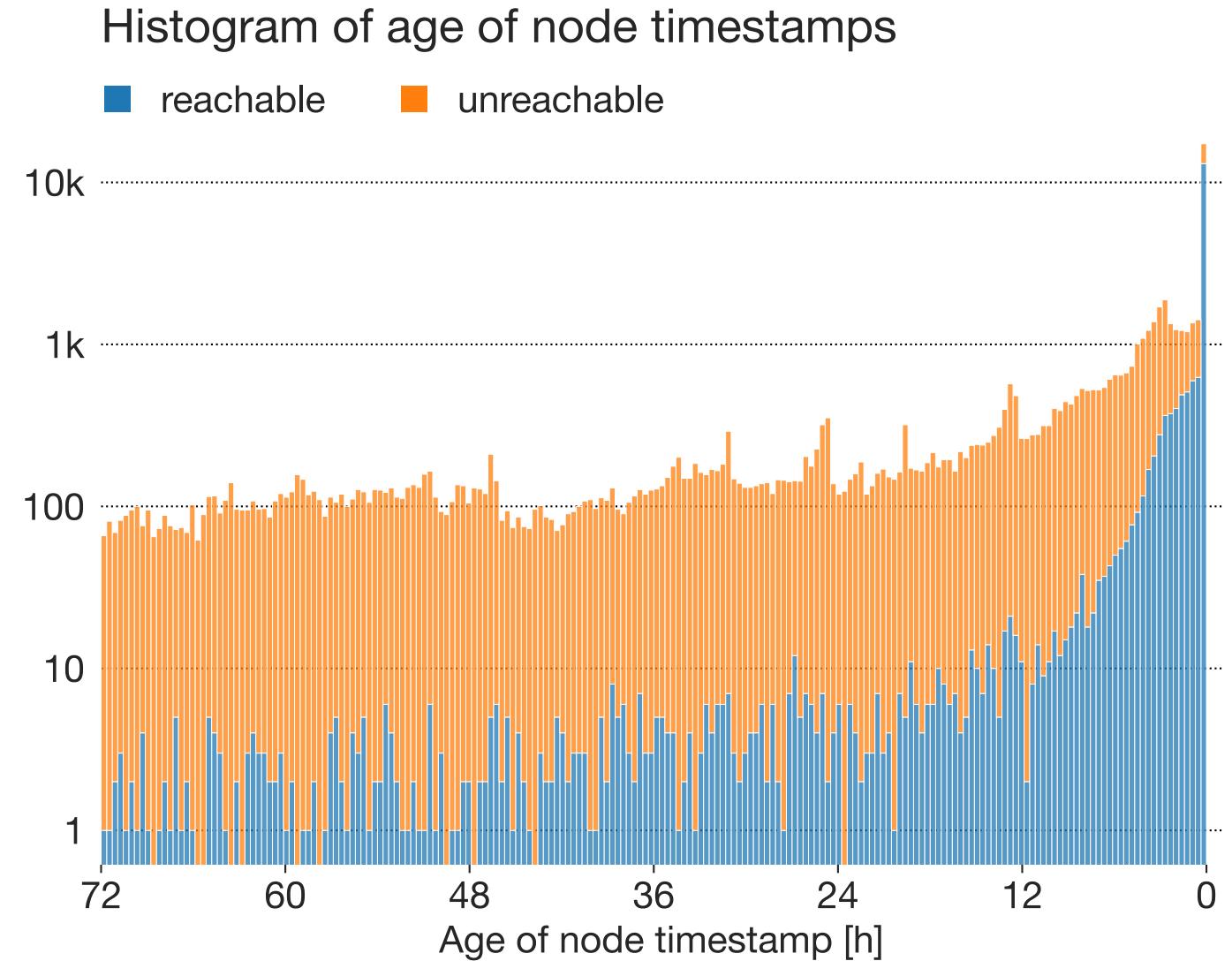
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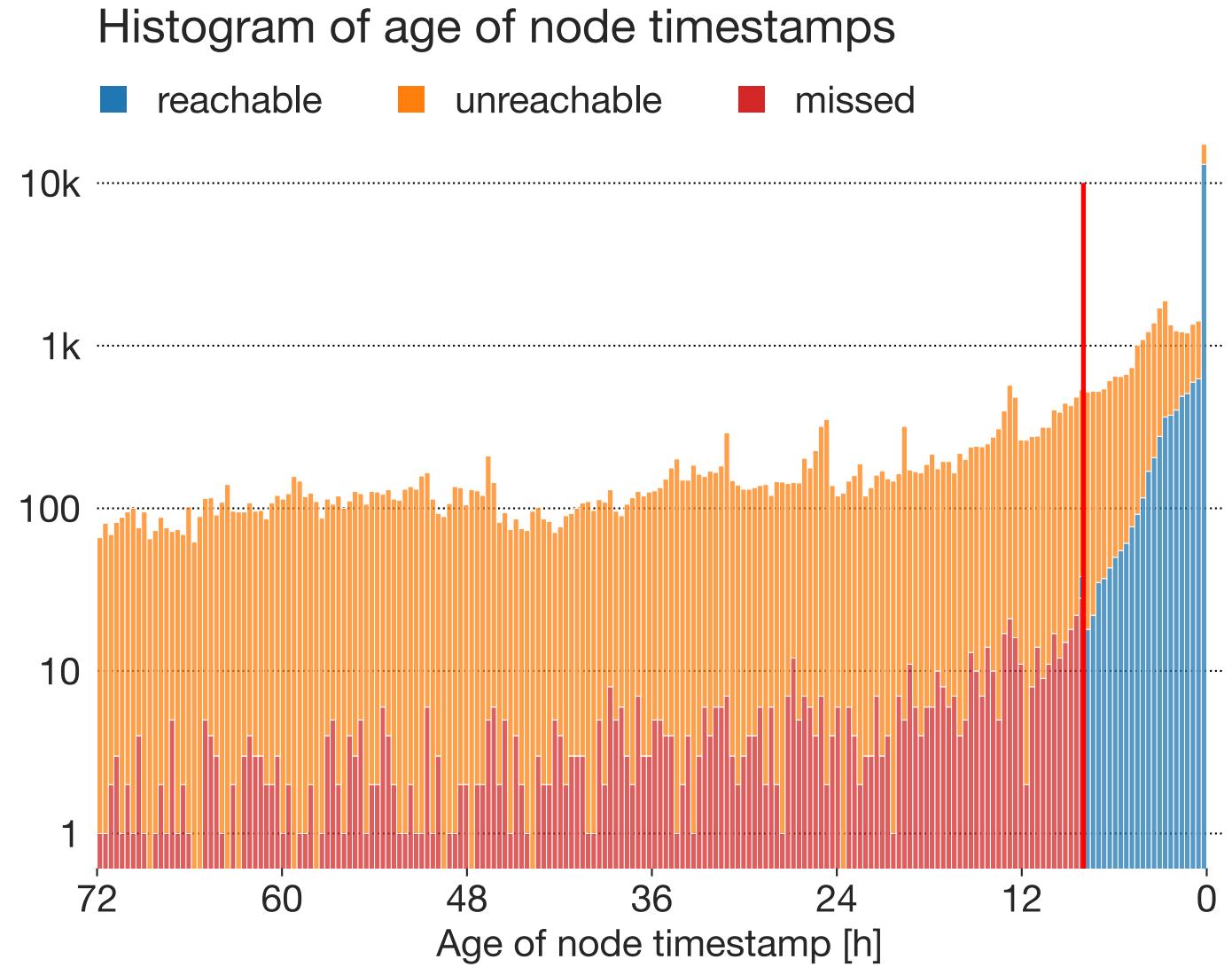
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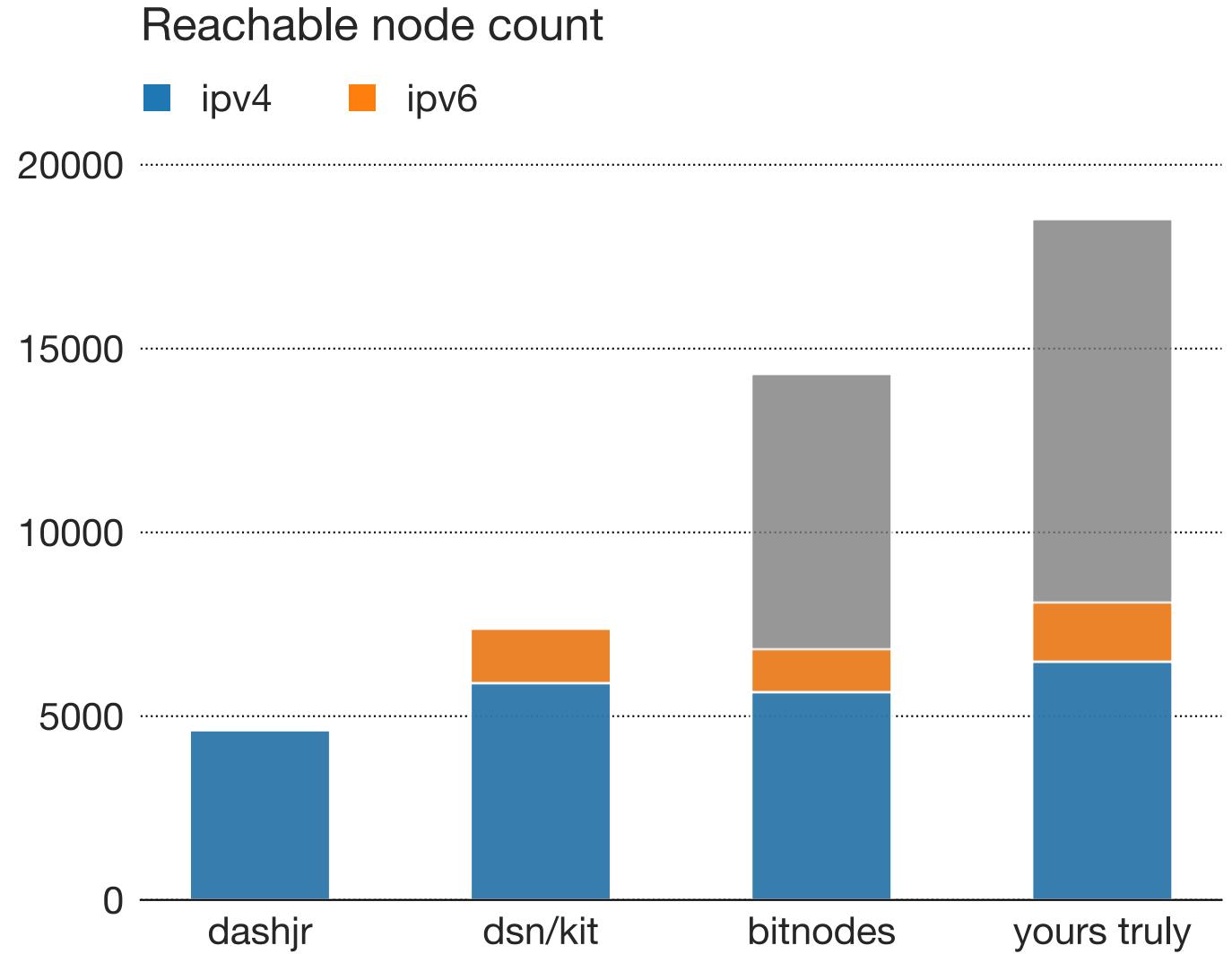
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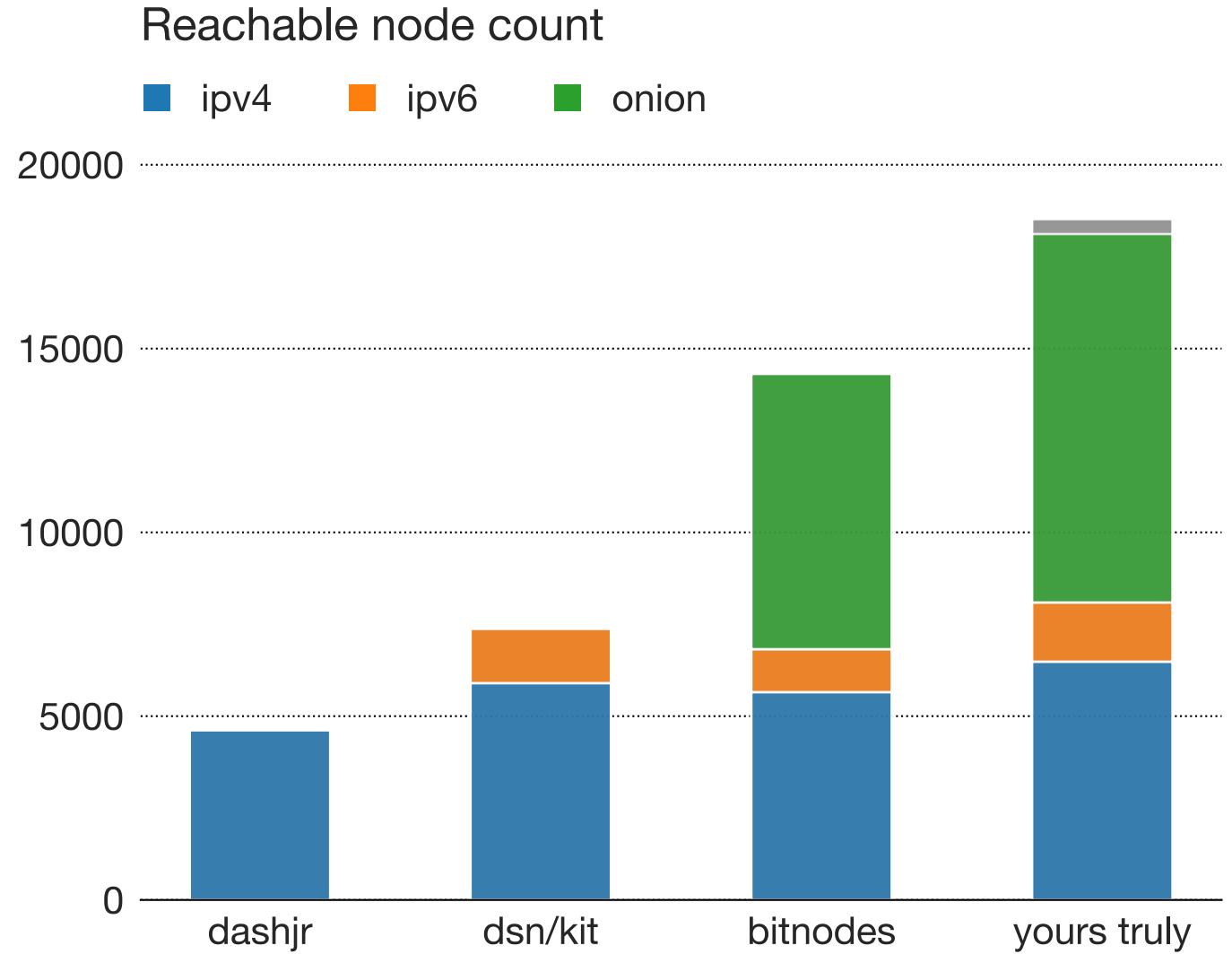
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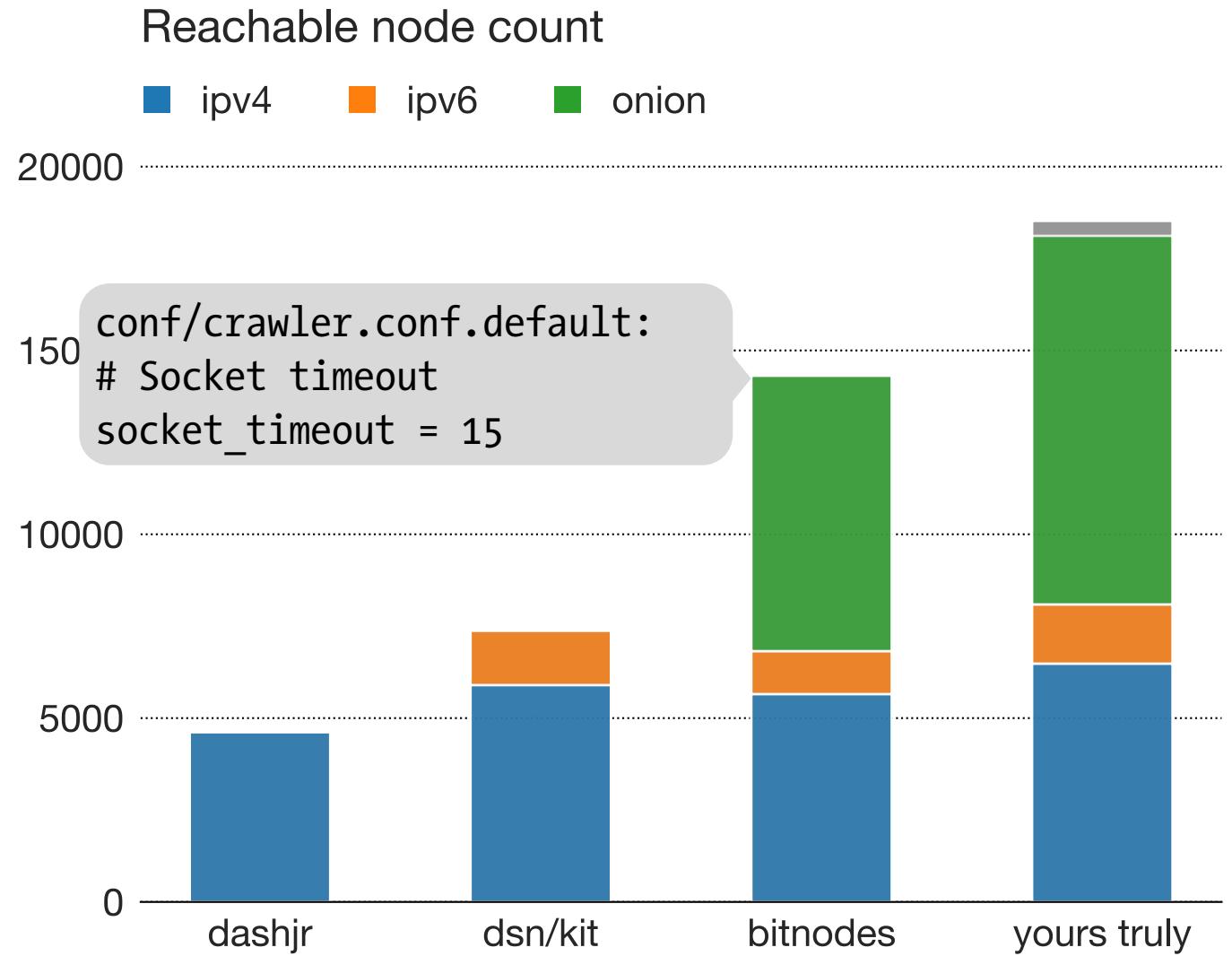
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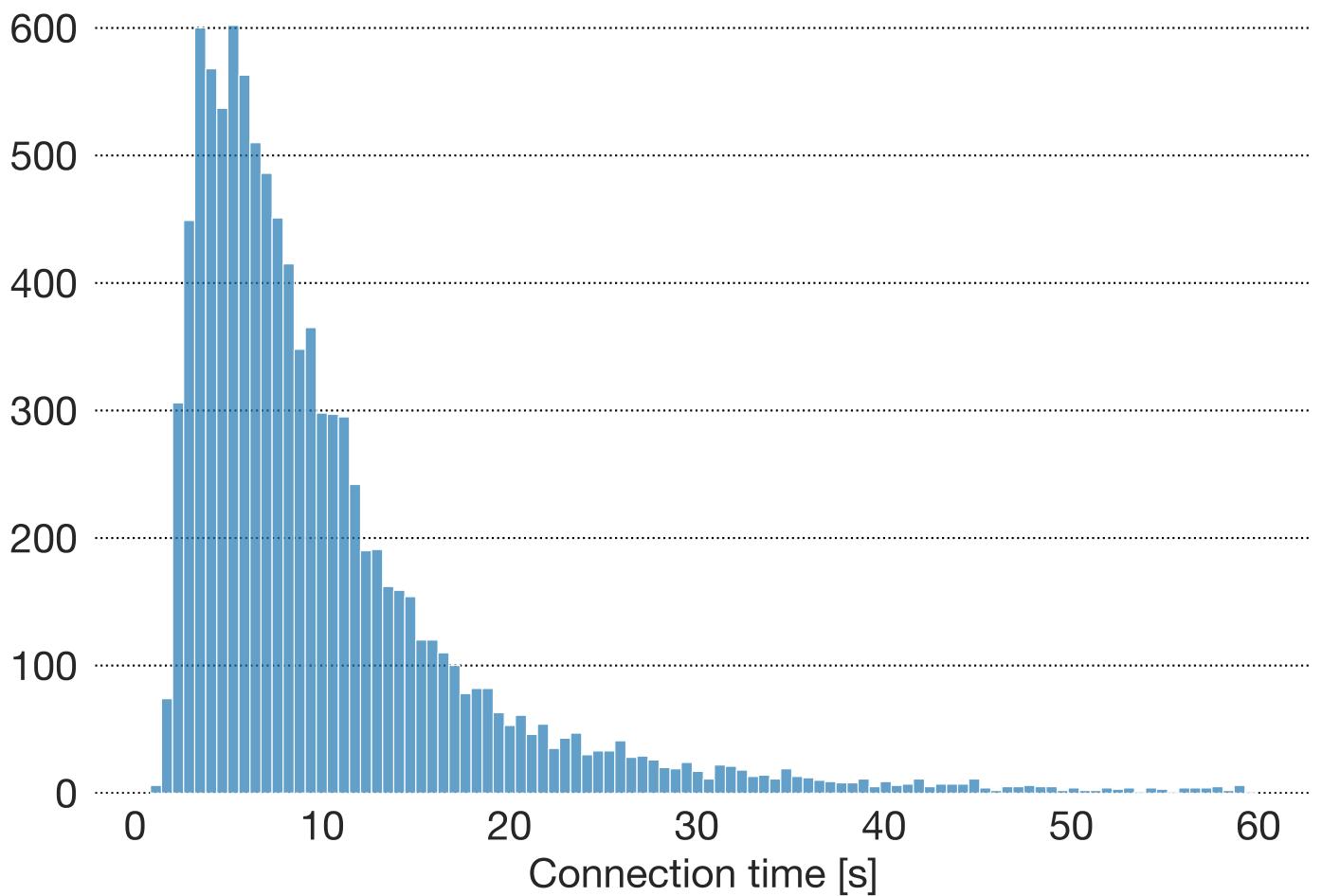
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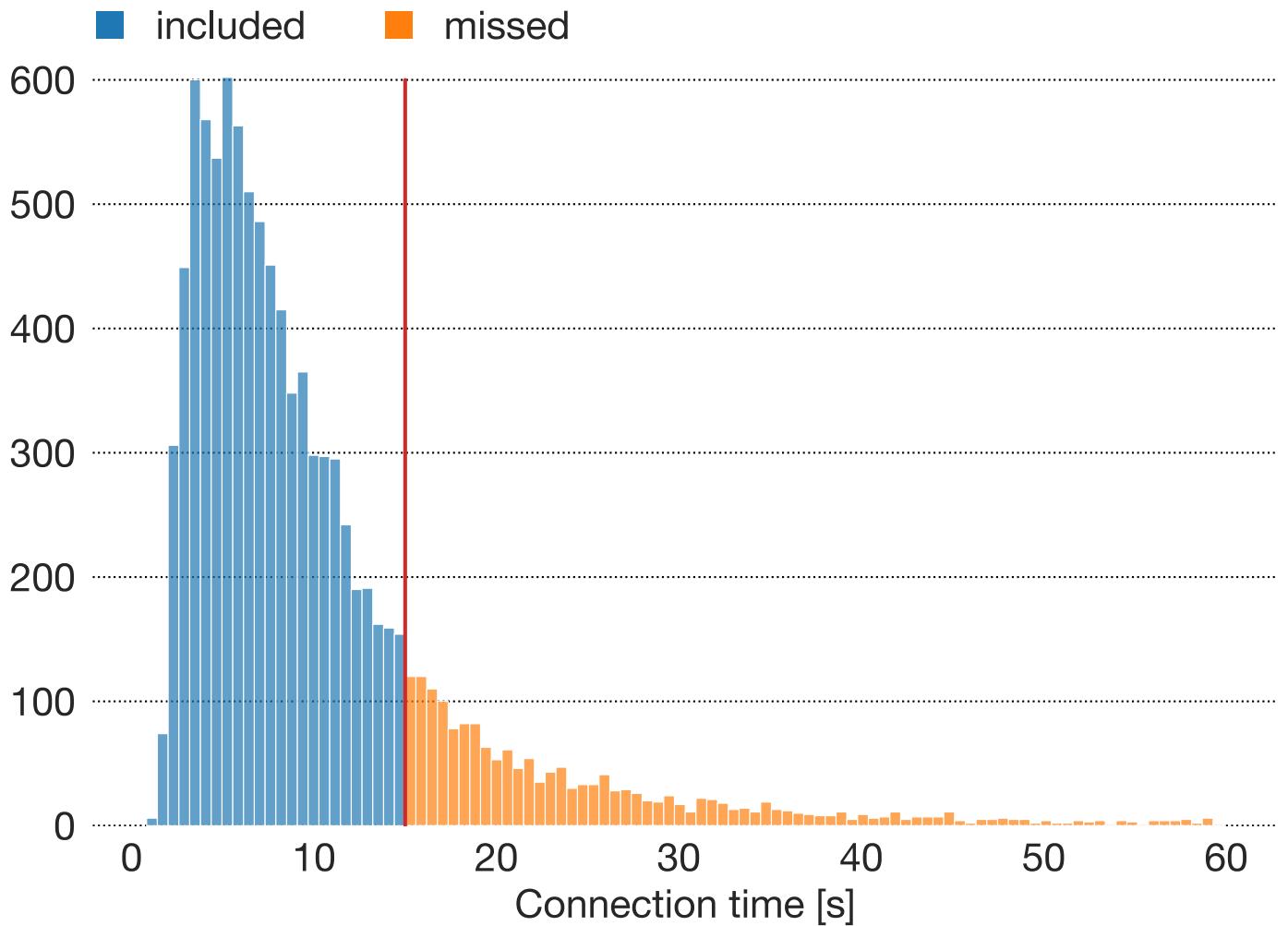
Histogram of v3 onion address connect times



Crawling the P2P network

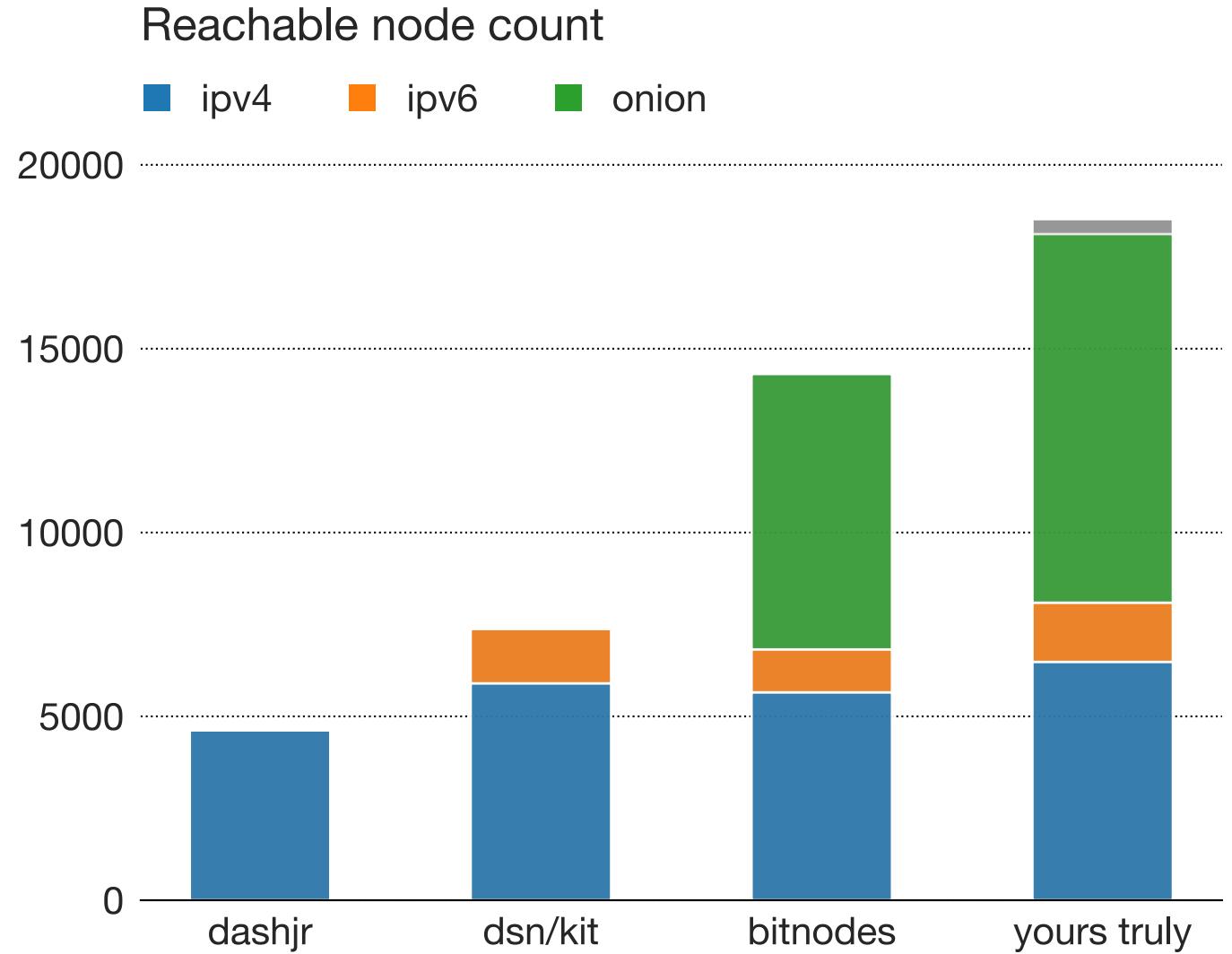
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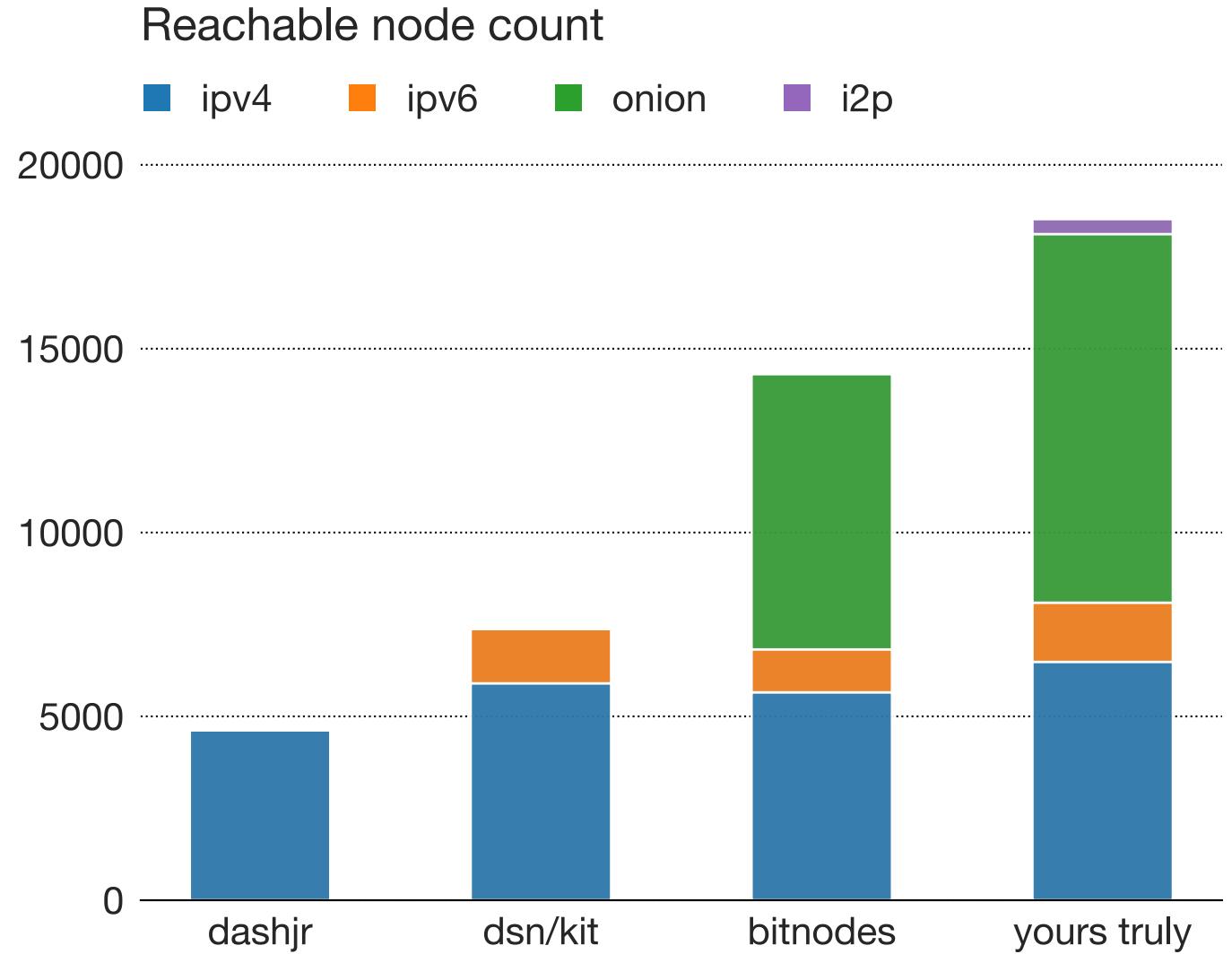
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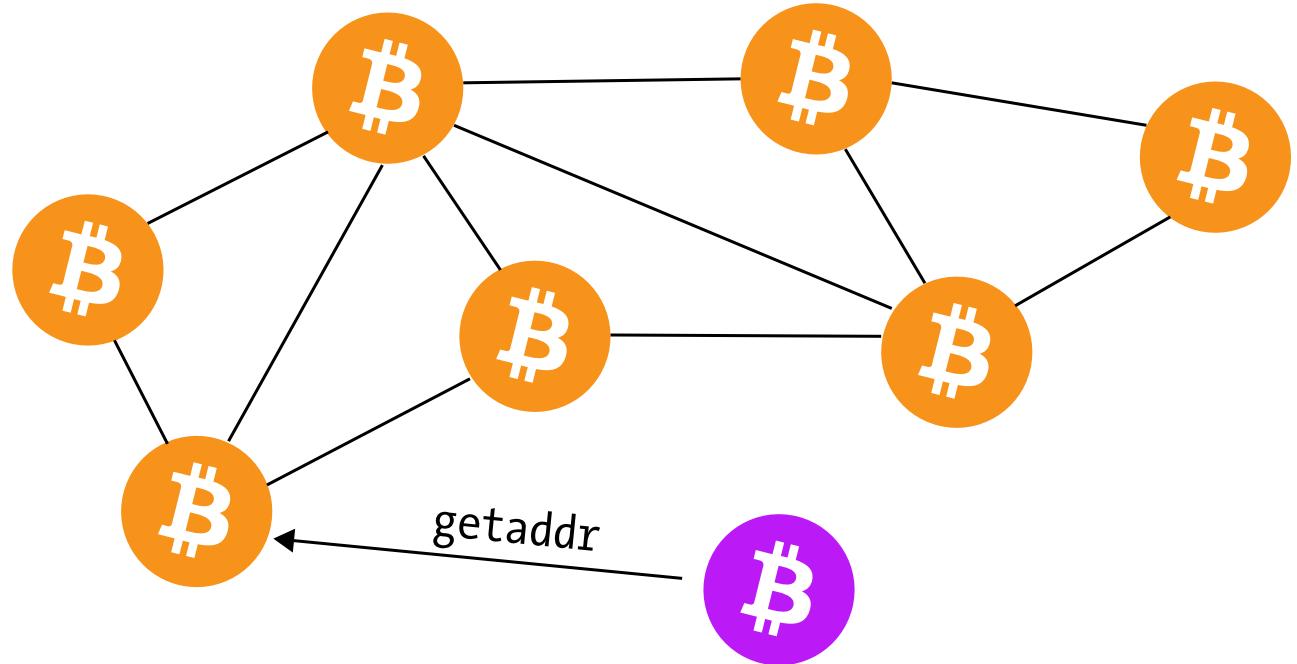


Insights 1: P2P network structure

- Address manager quirks

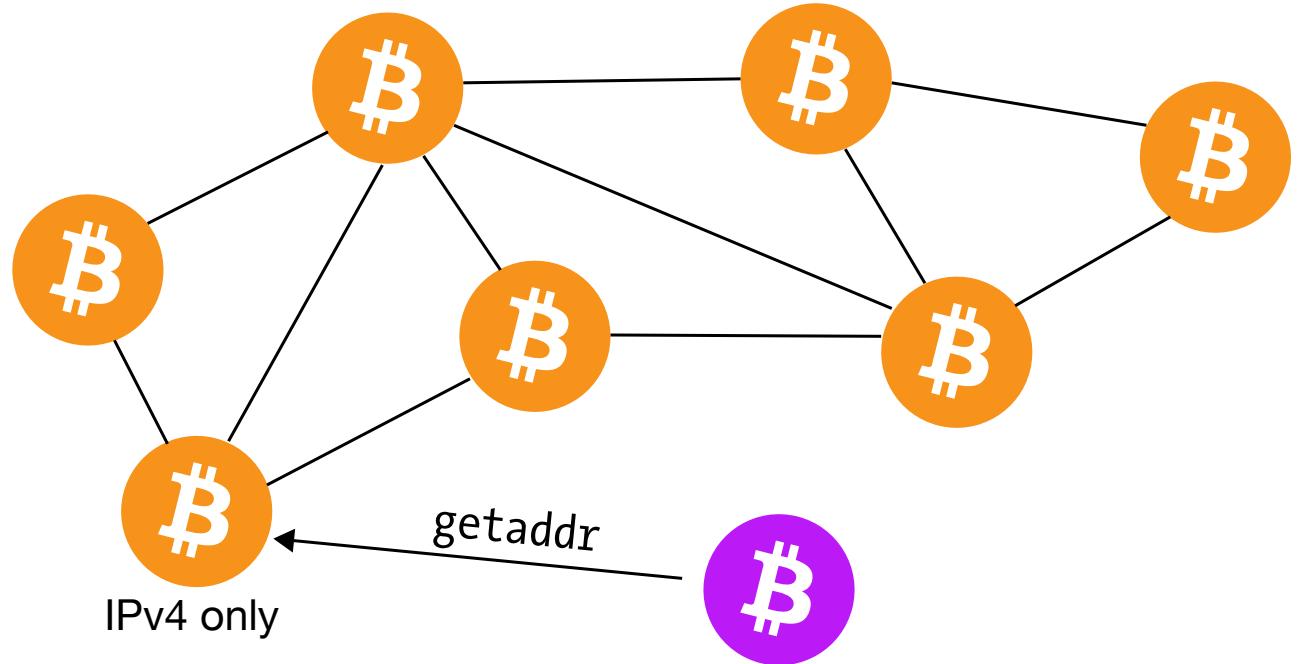
Insights 1: P2P network structure

- Address manager quirks



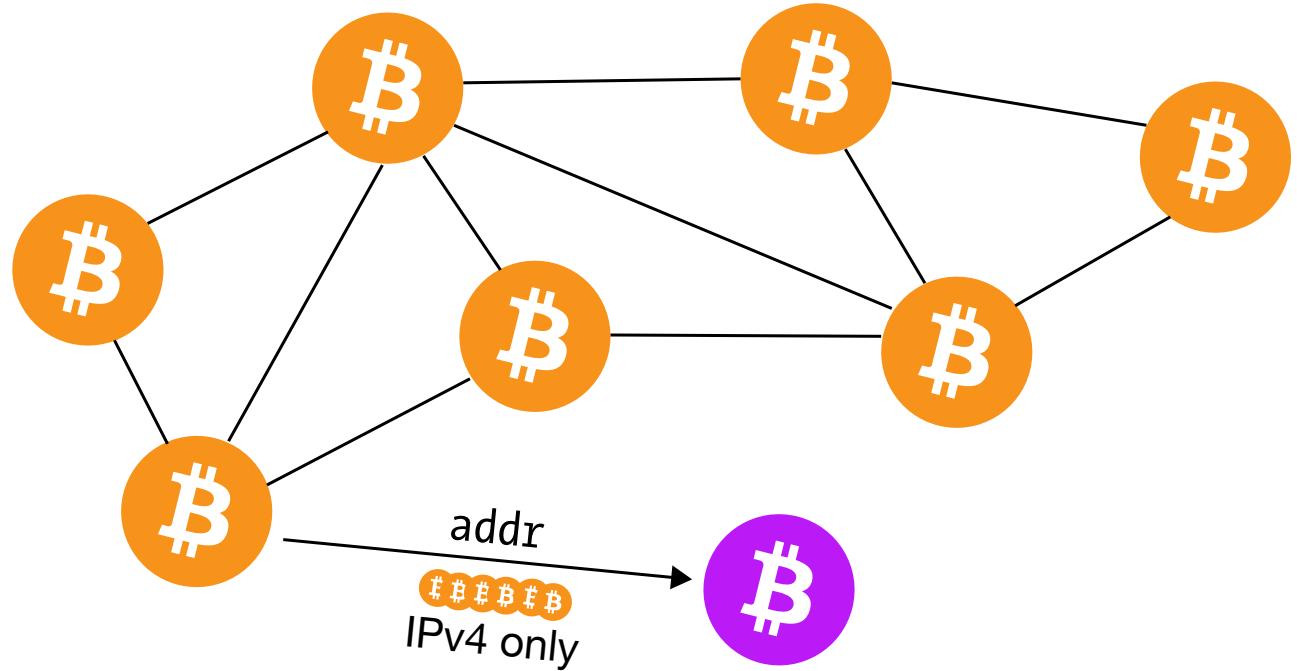
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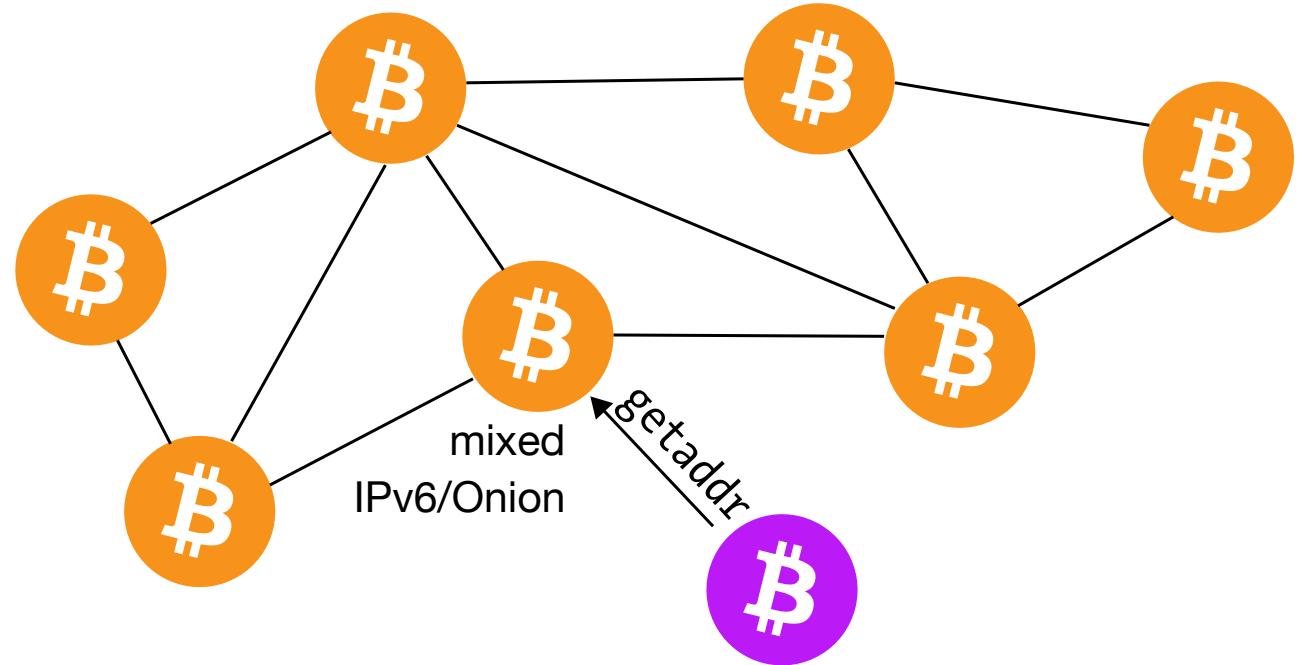
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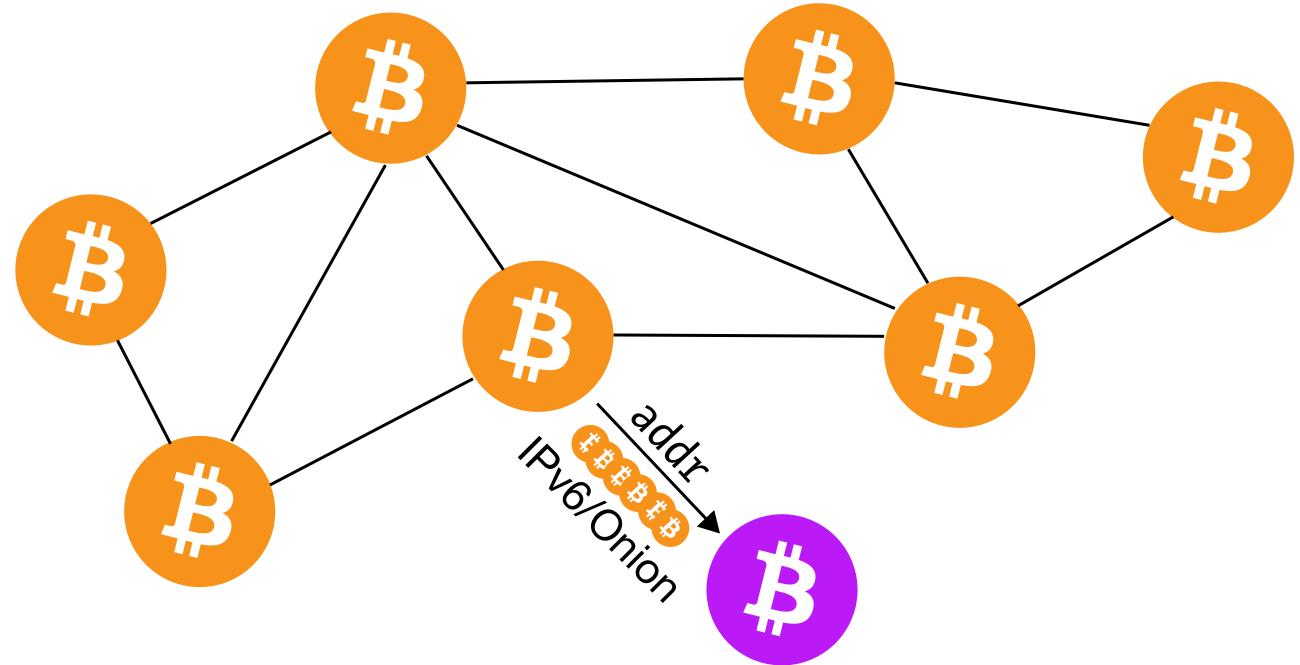
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Insights 1: P2P network structure

- Address manager quirks
 - Infer node networks

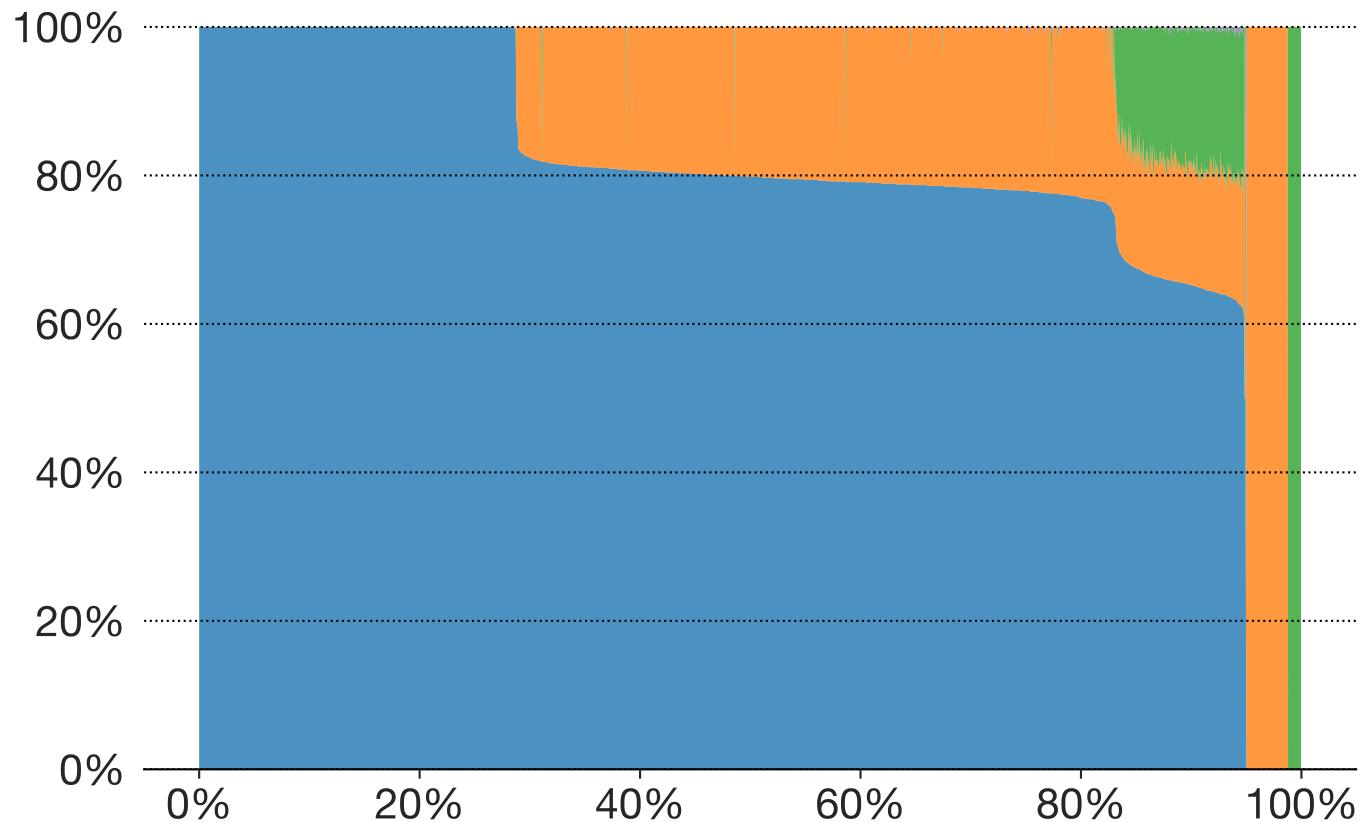


Insights 1: P2P network structure

- Address manager quirks
 - Infer node networks

IPv4 node addr messages net share

■ ipv4 ■ ipv6 ■ onion ■ i2p

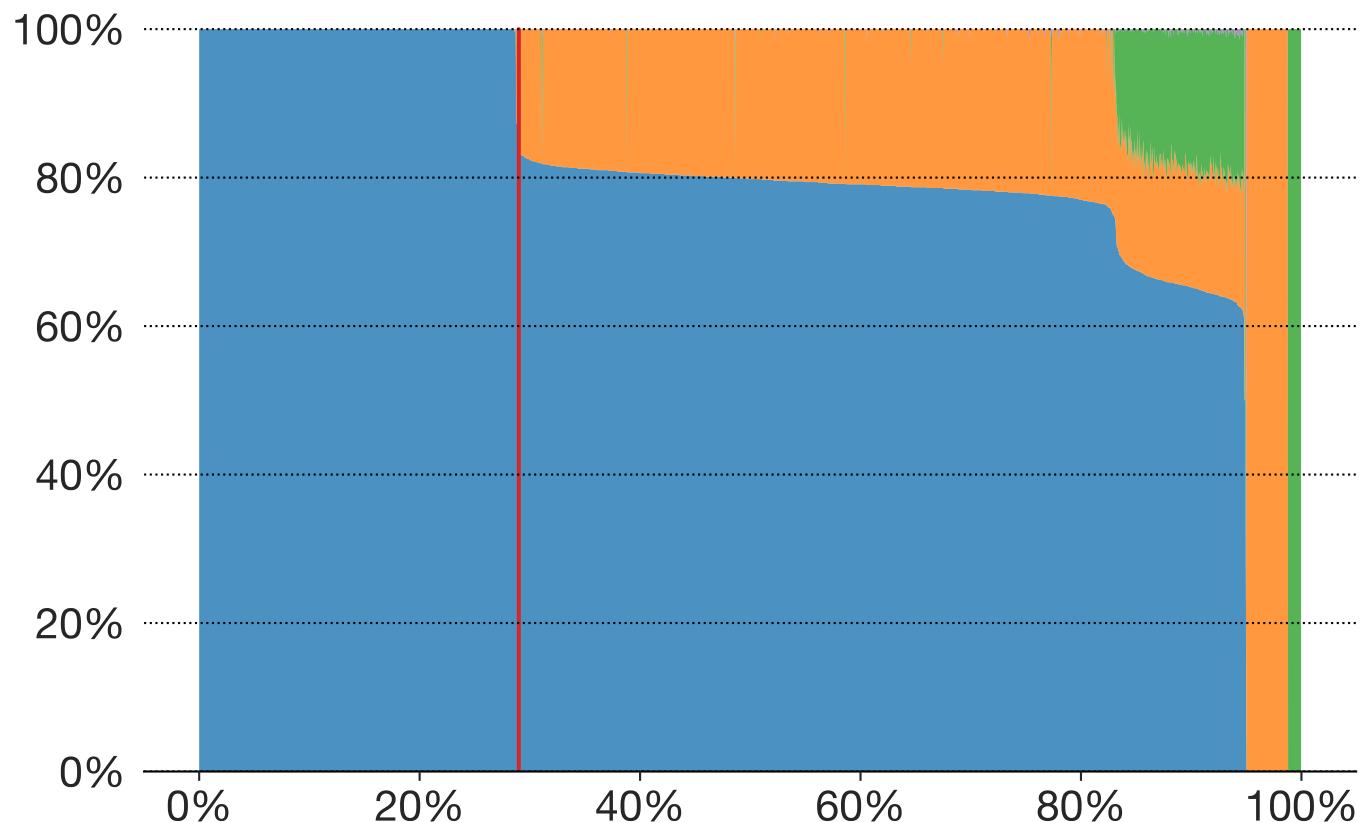


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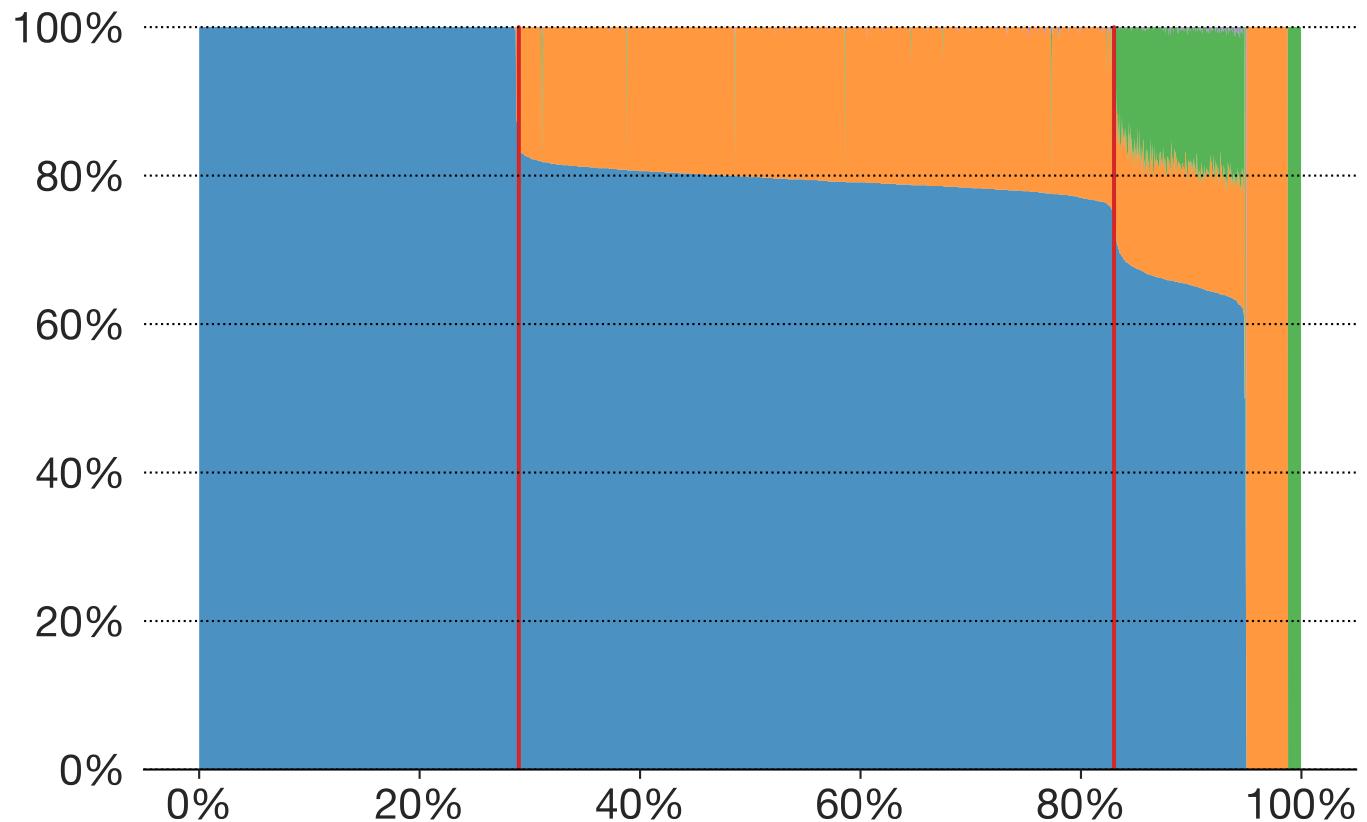


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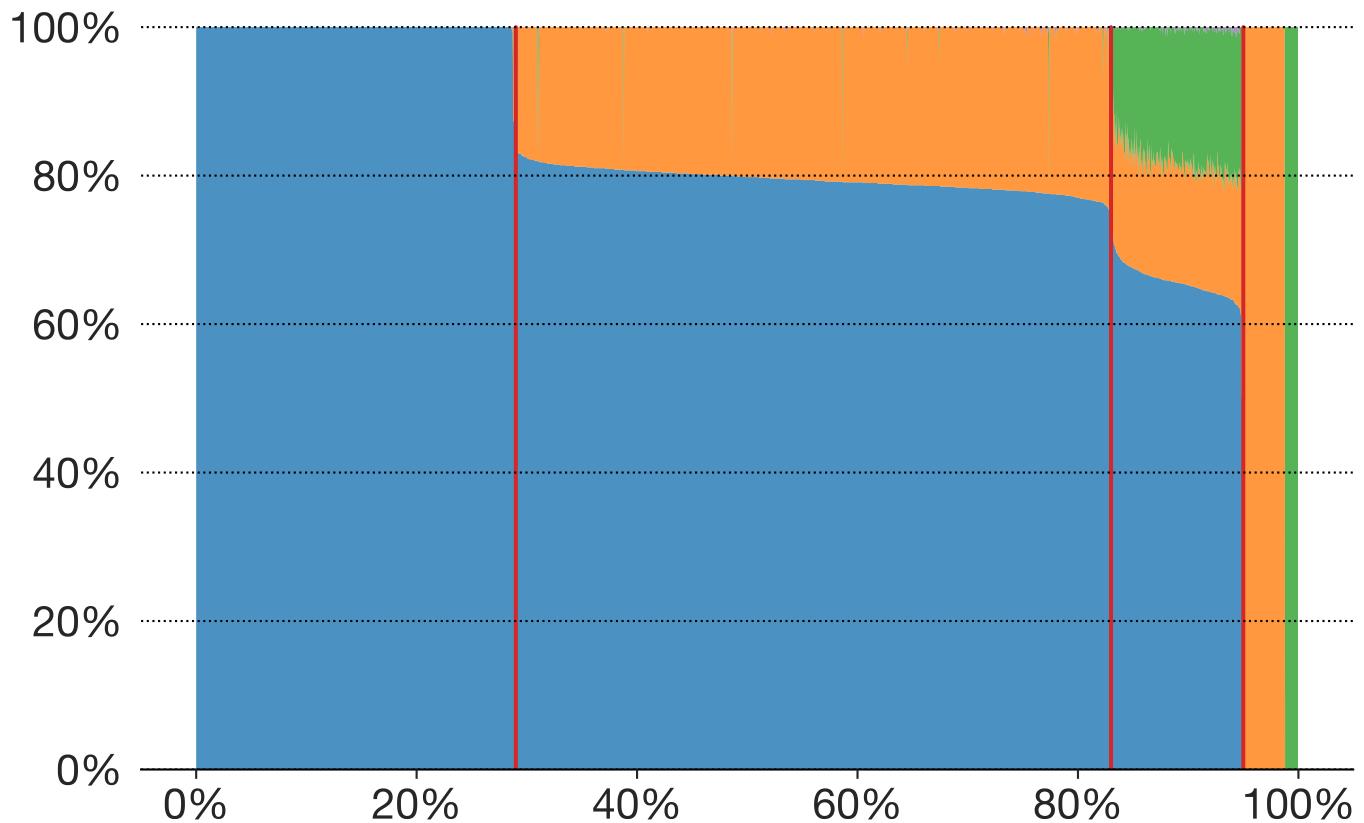


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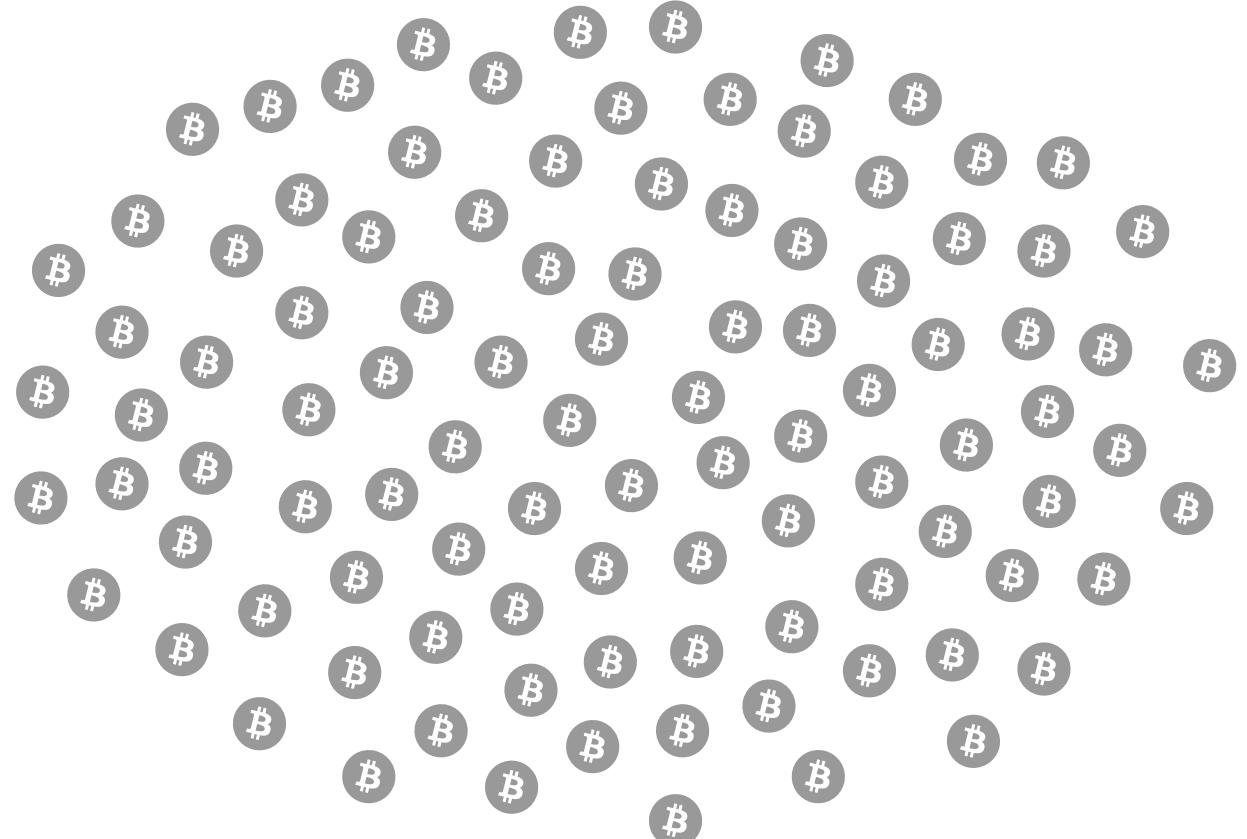
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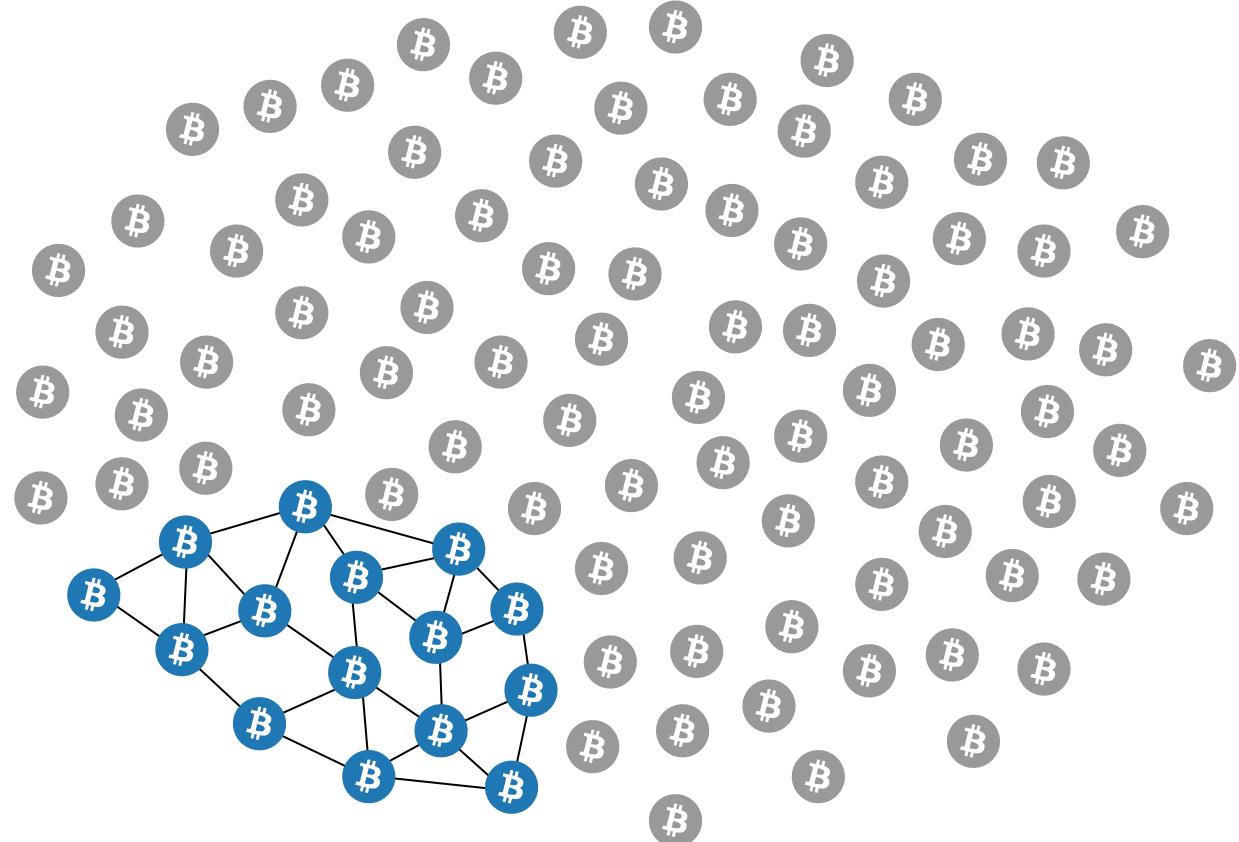
Insights 1: P2P network structure

- Address manager quirks
 - Infer node networks
- Around 13,000 unique nodes
(about 70% of 18,500 total nodes)



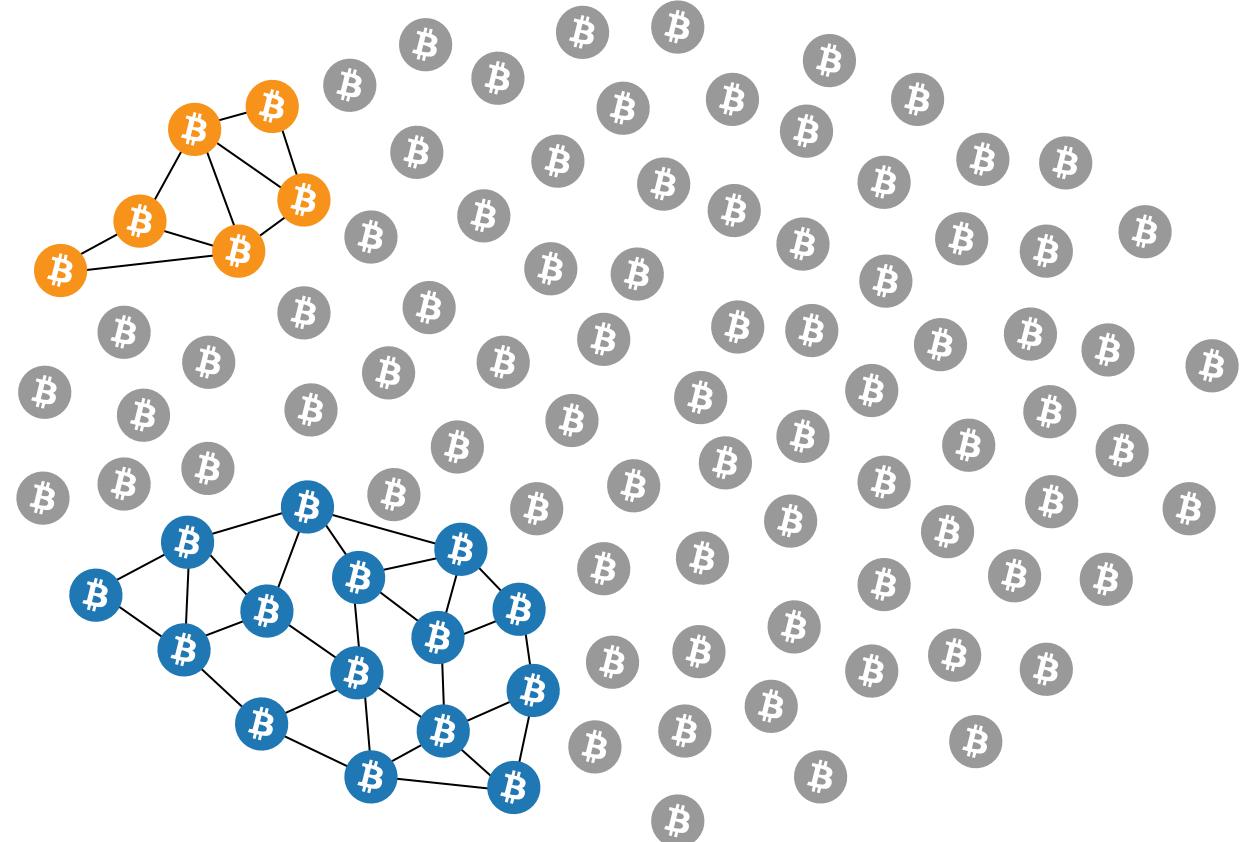
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 - 15% IPv4



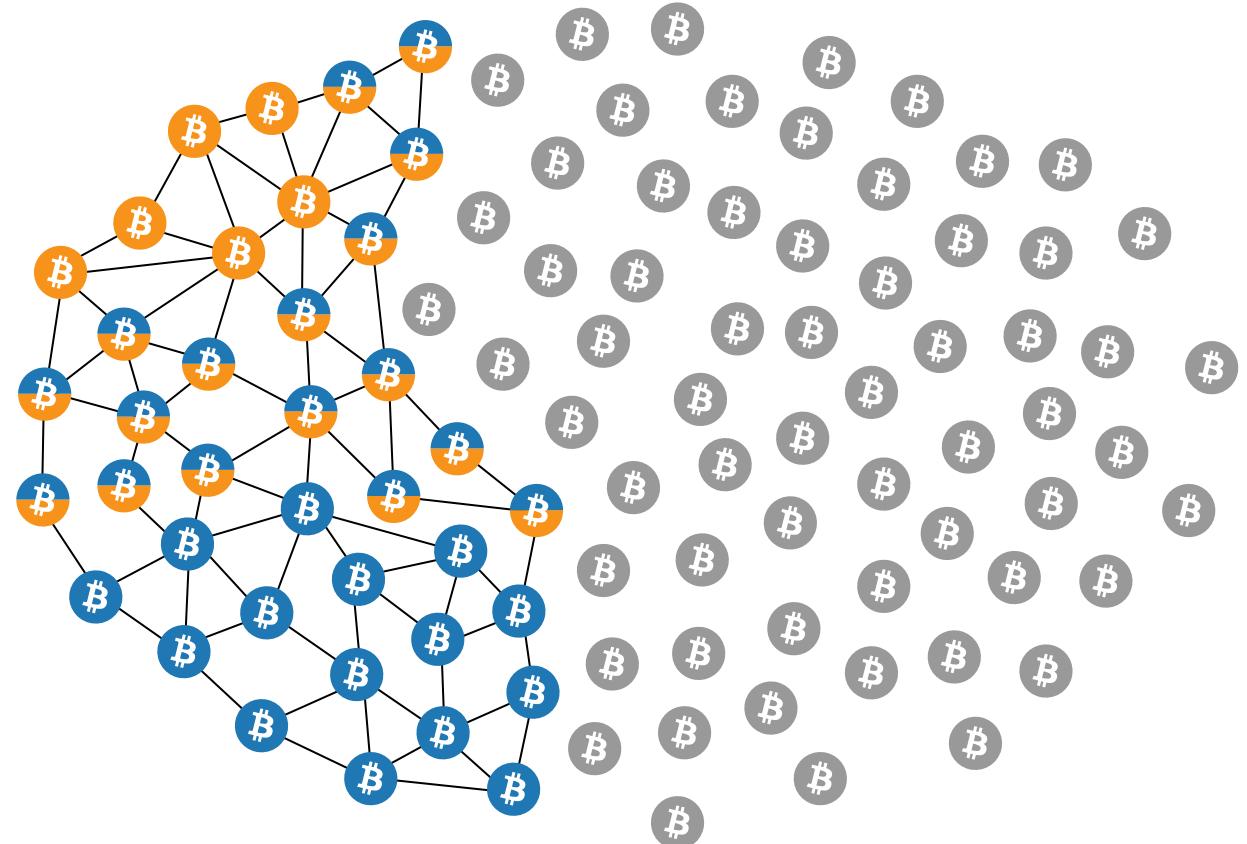
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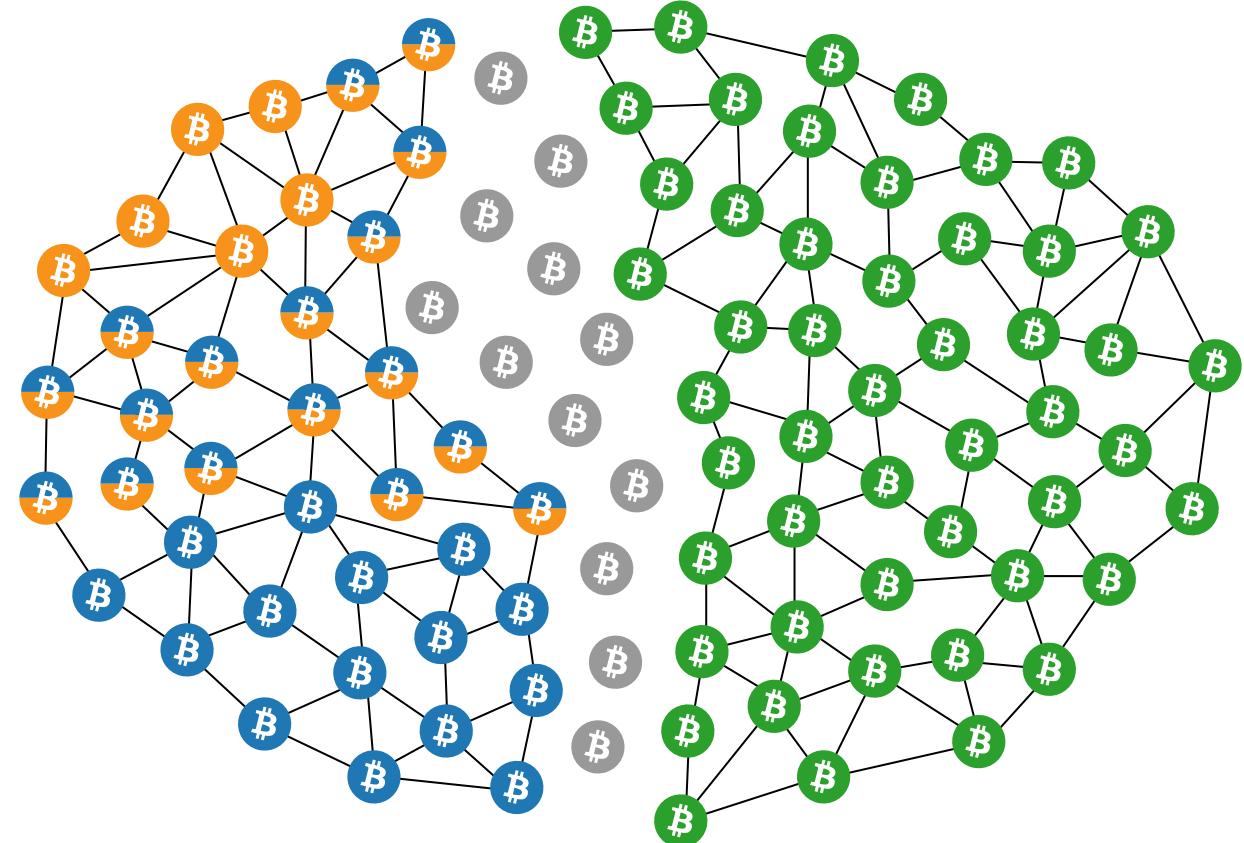
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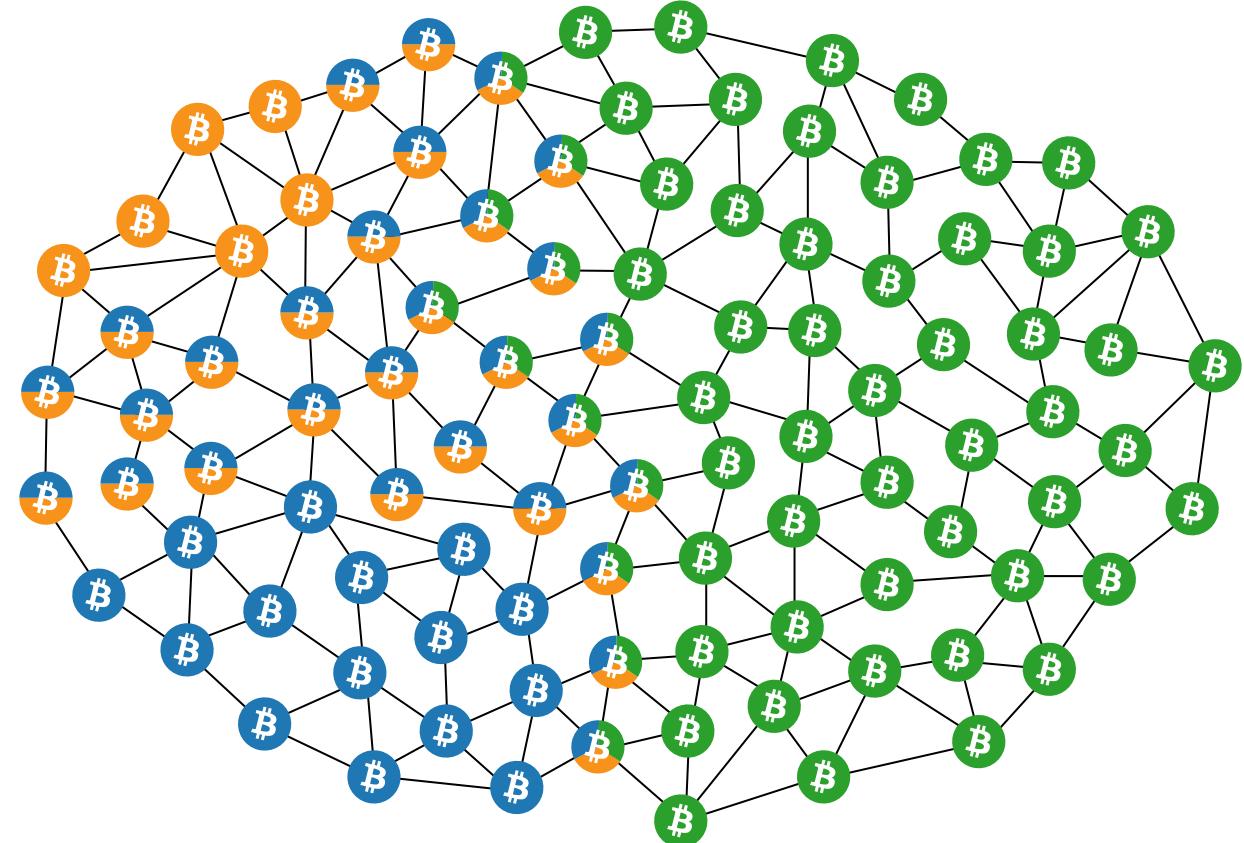
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 - 50% Onion



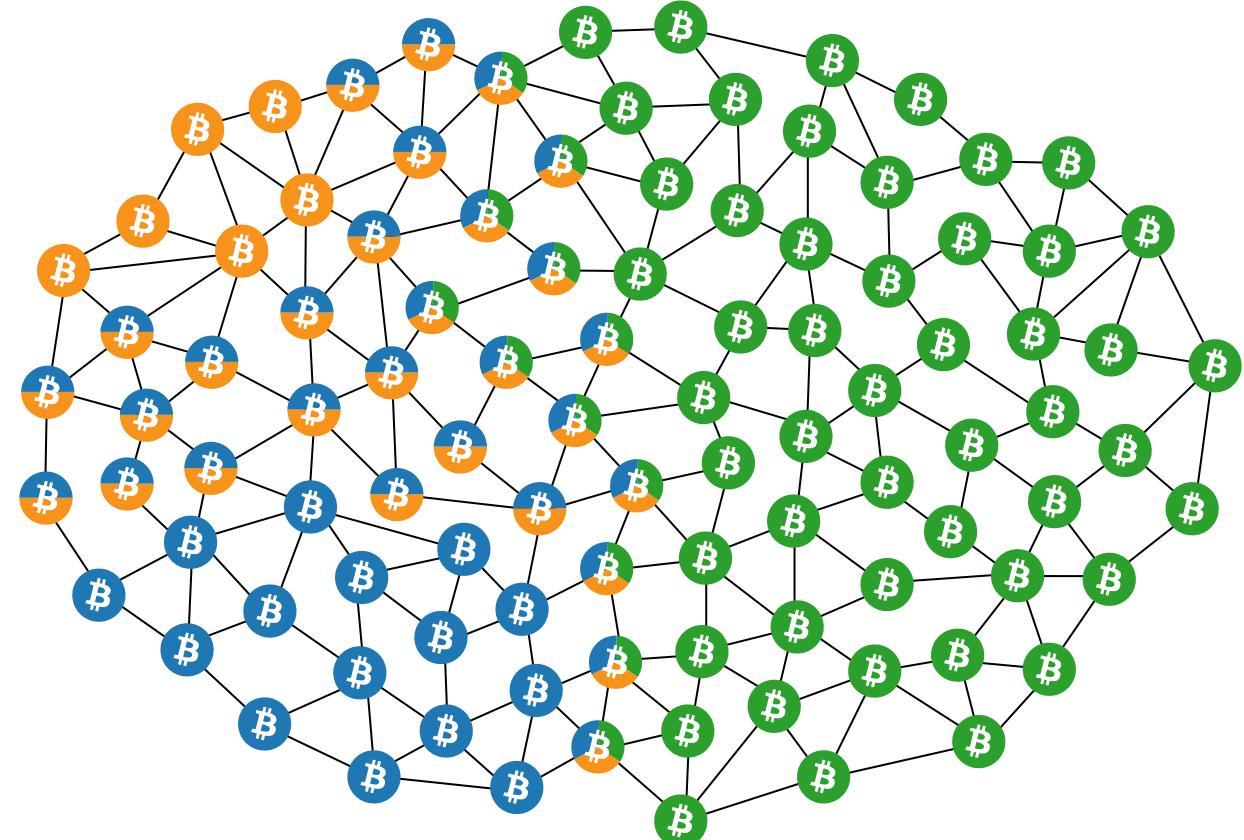
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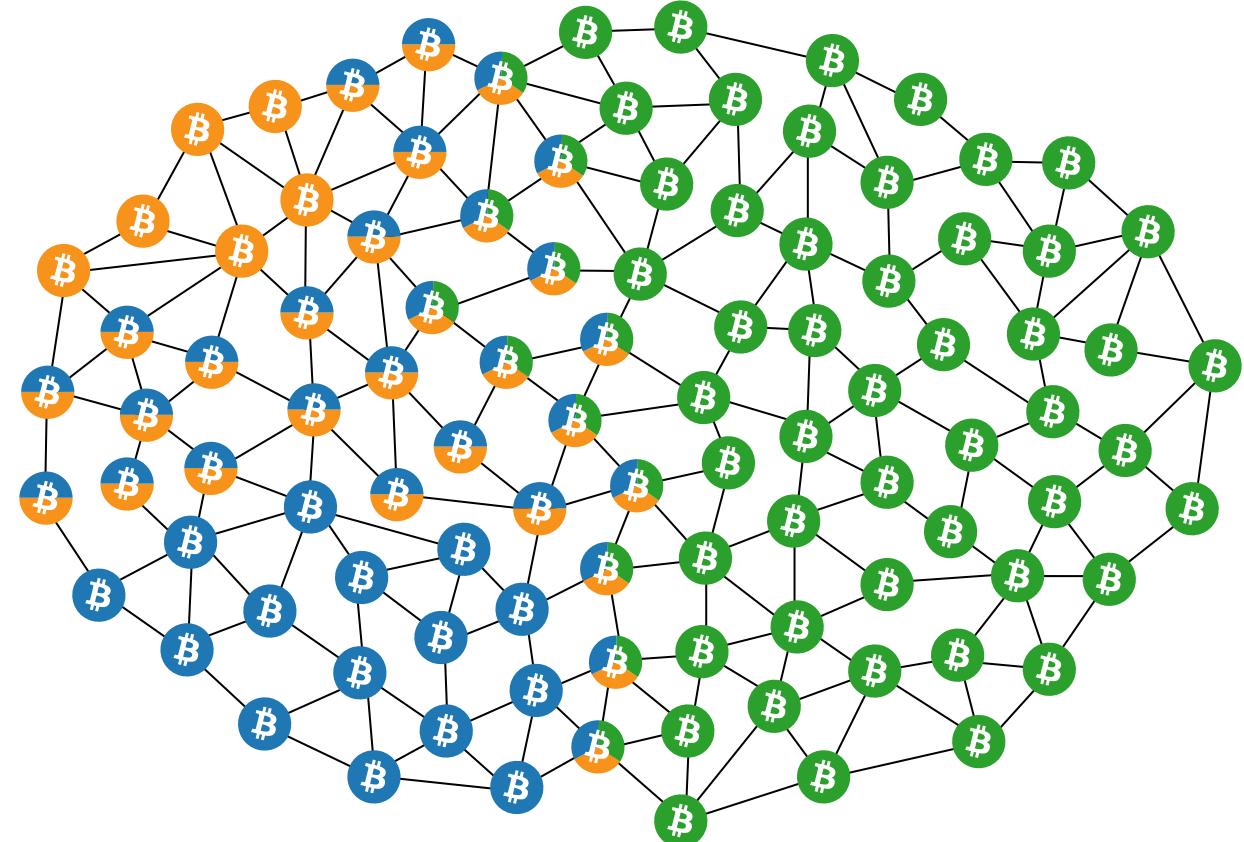
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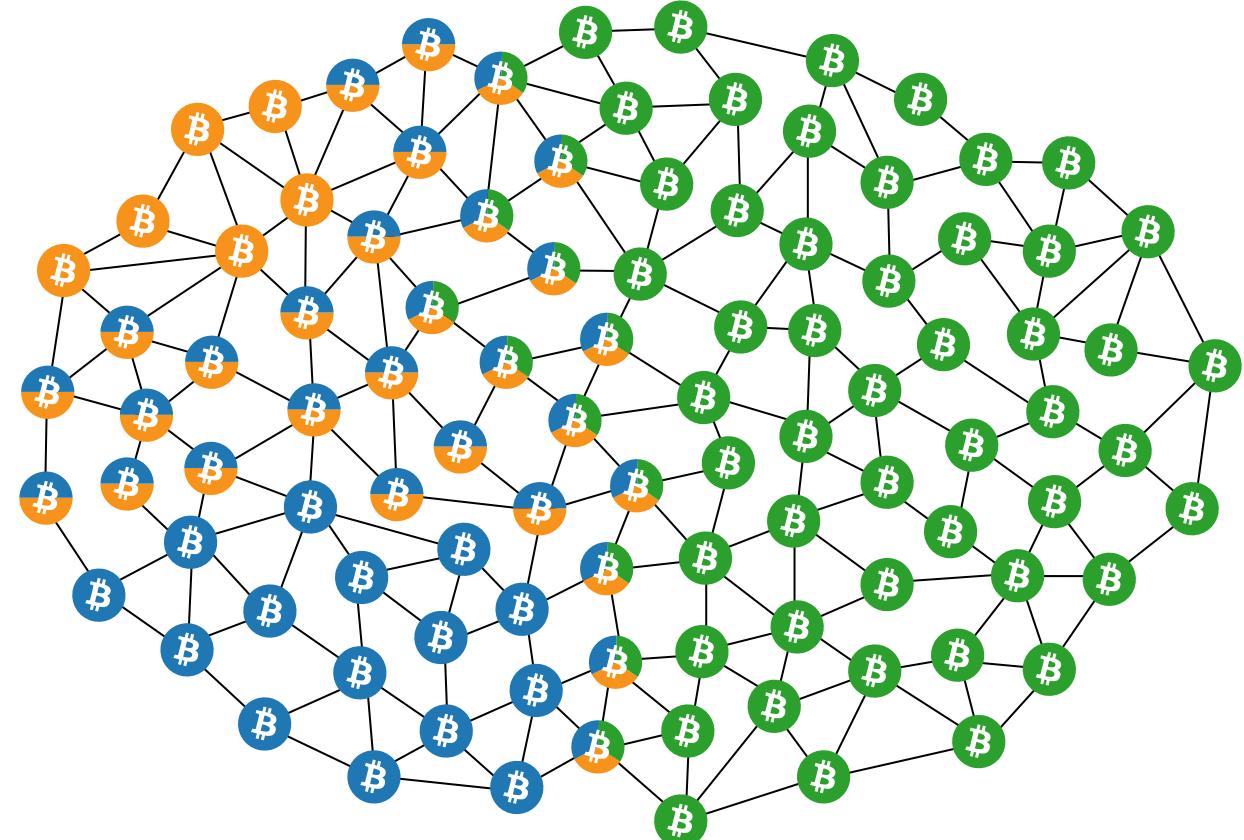
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 - Good network cohesion
 - Important to maintain multi-network nodes



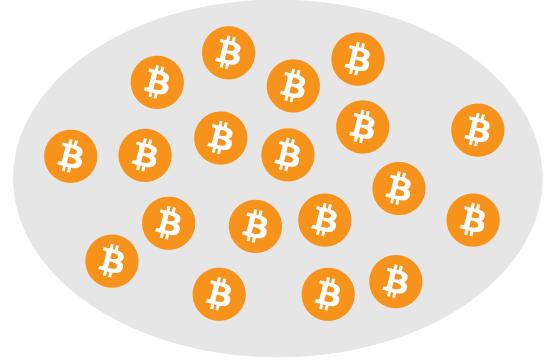
Insights 2: Autonomous systems

- Why care about AS?

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- Why care about AS?

Google
1.1.1.0/24, 2.2.0.0/16, etc.

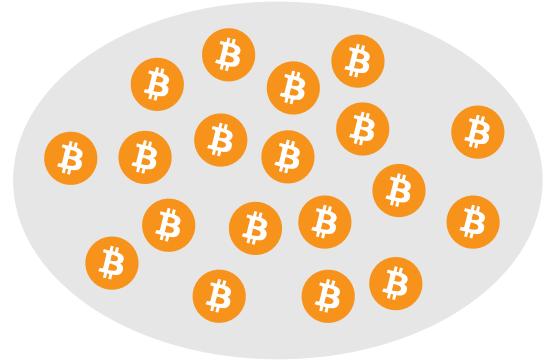


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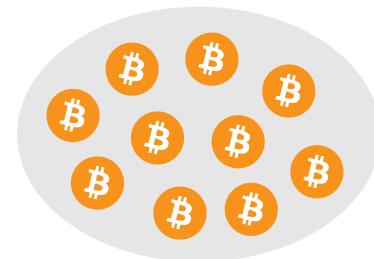
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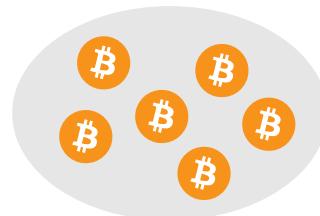
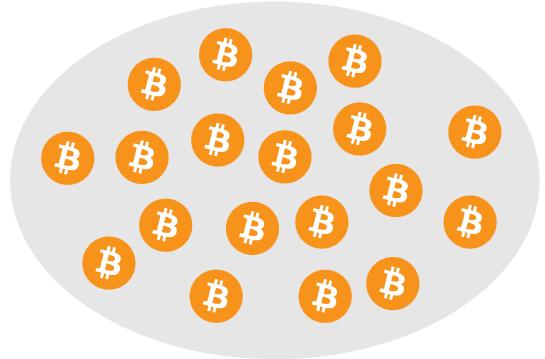
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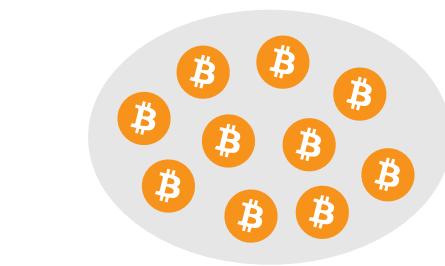
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Insights 2: Autonomous systems

- Why care about AS?

Smaller ISP

5.5.0.0/16



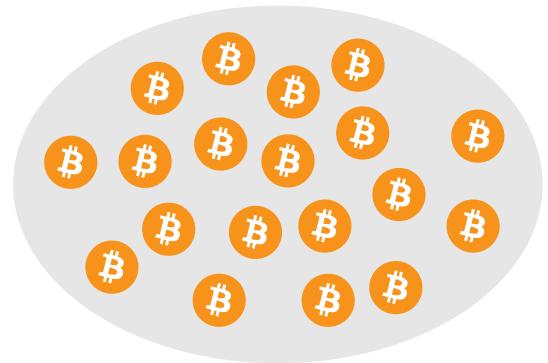
Tiny ISP

6.6.6.0/24



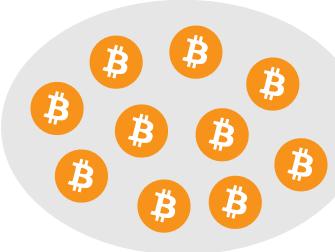
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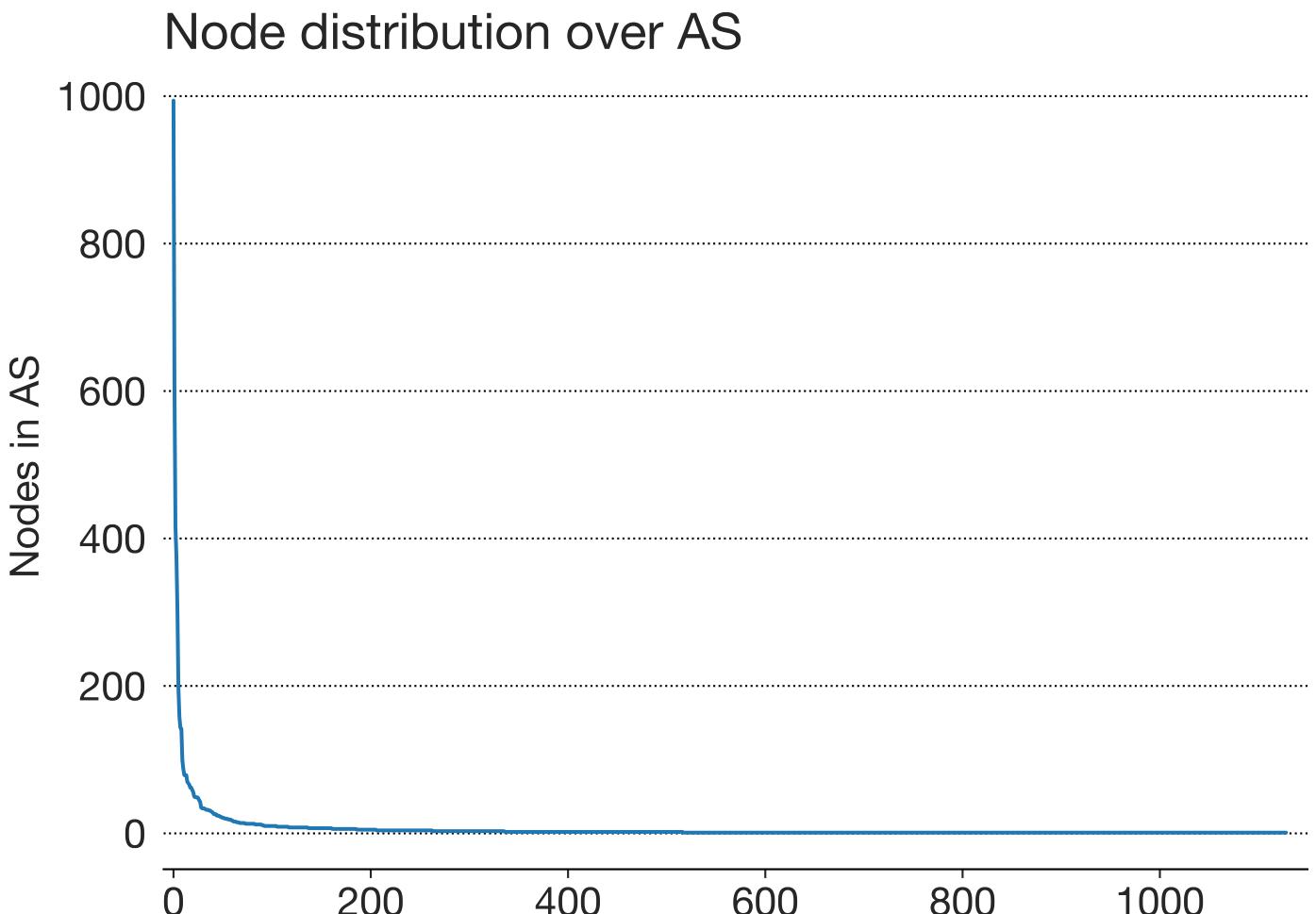


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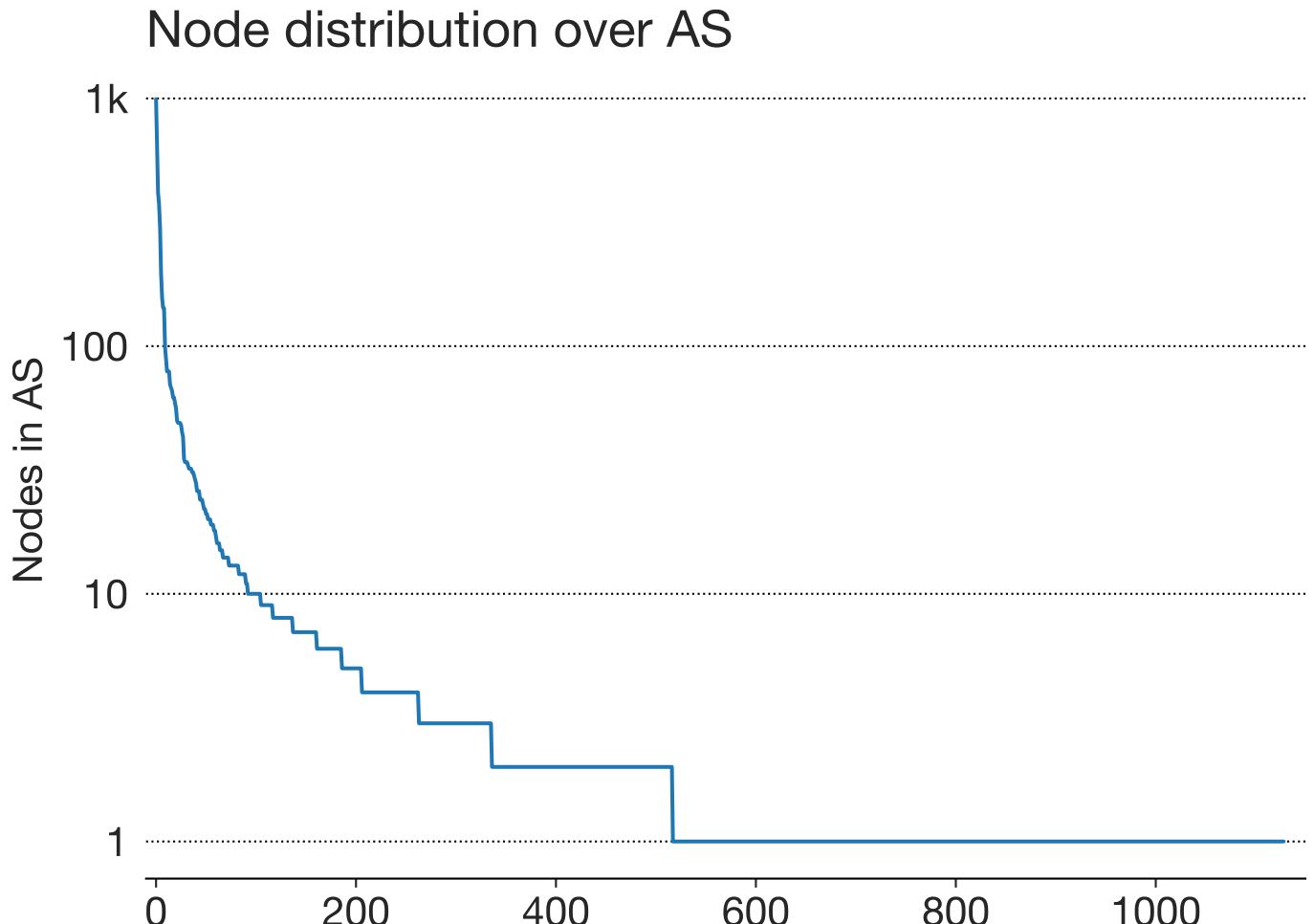
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 - Around 8000 IP nodes, 1100 AS
 - Power law



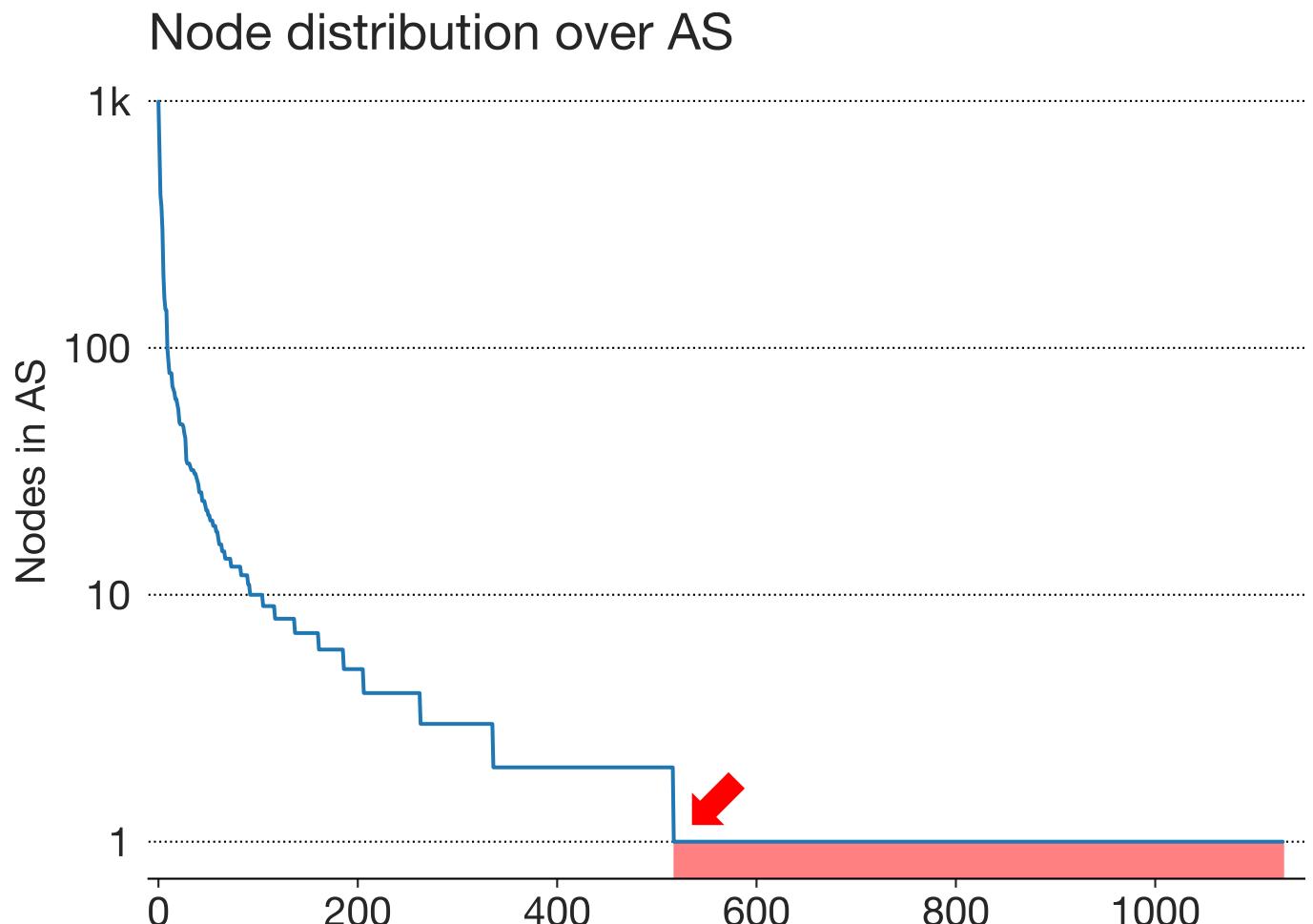
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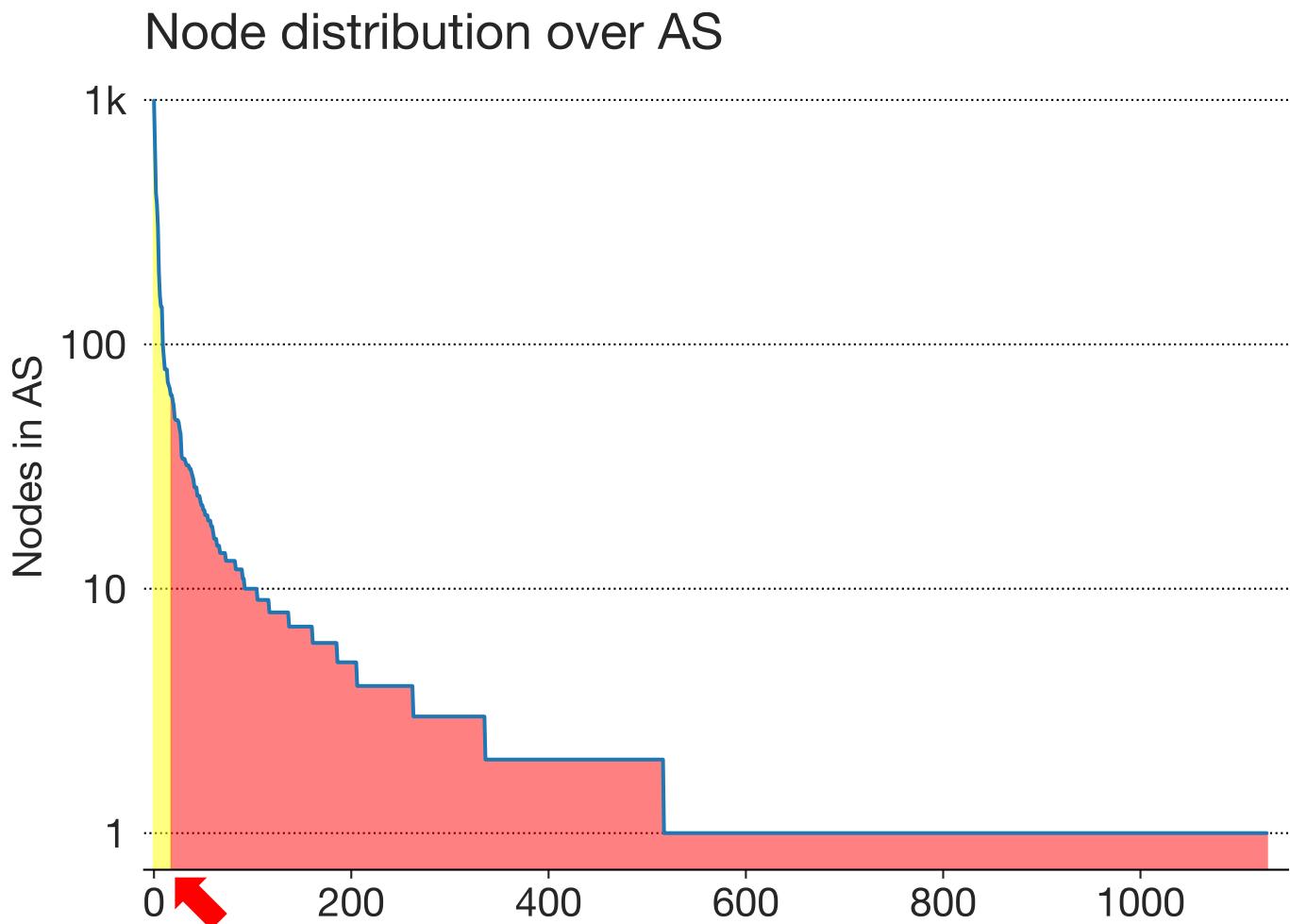
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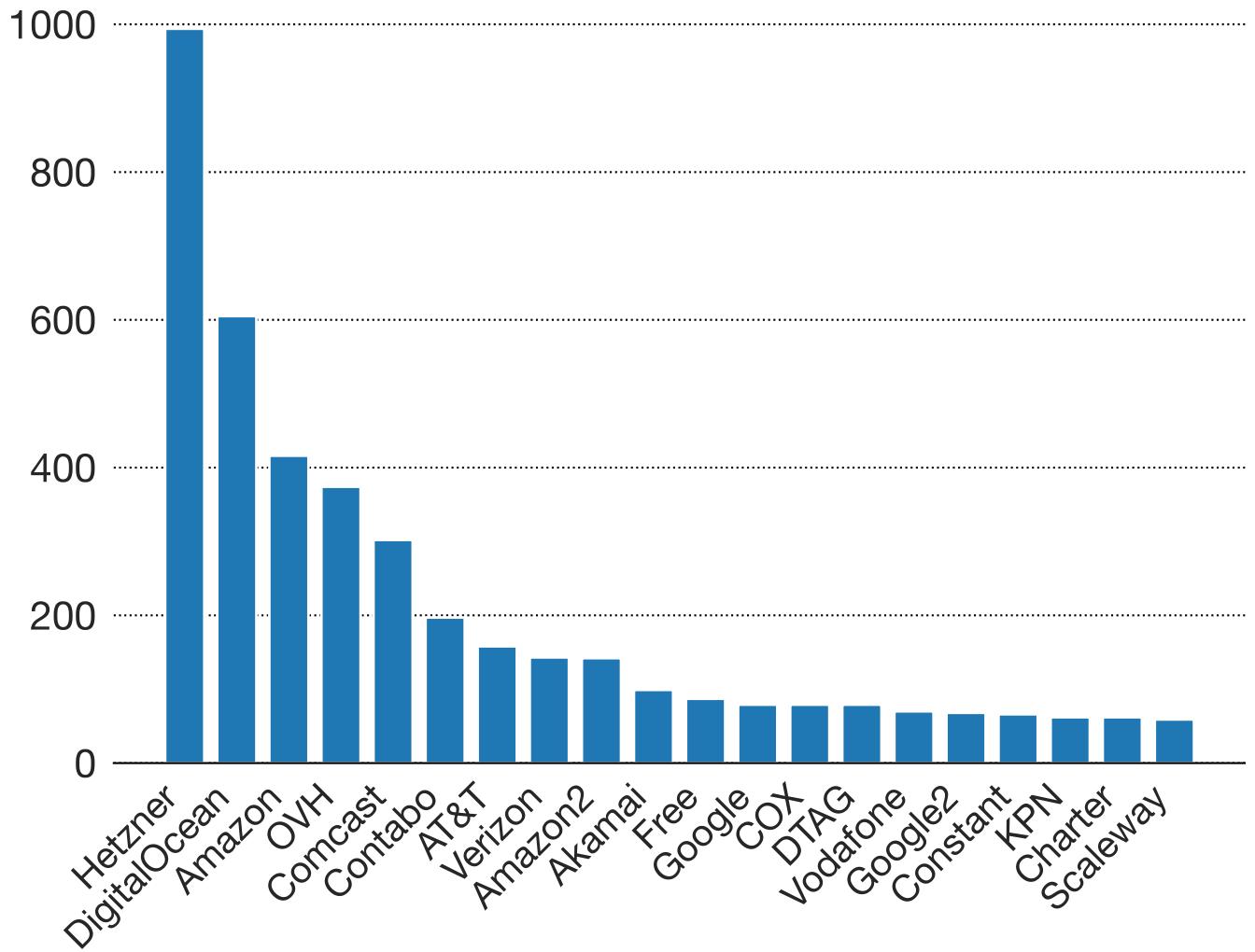
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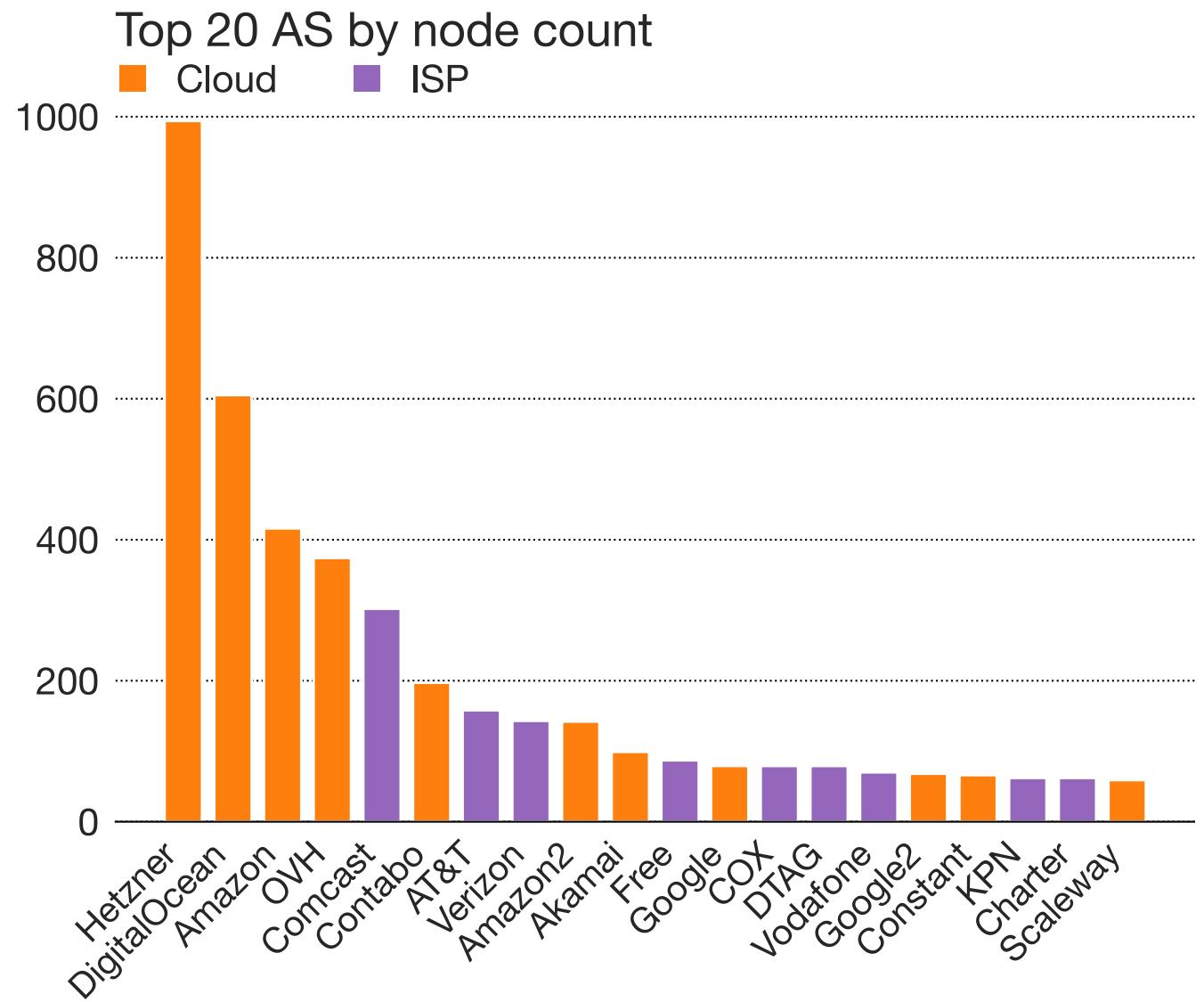
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Top 20 AS by node count



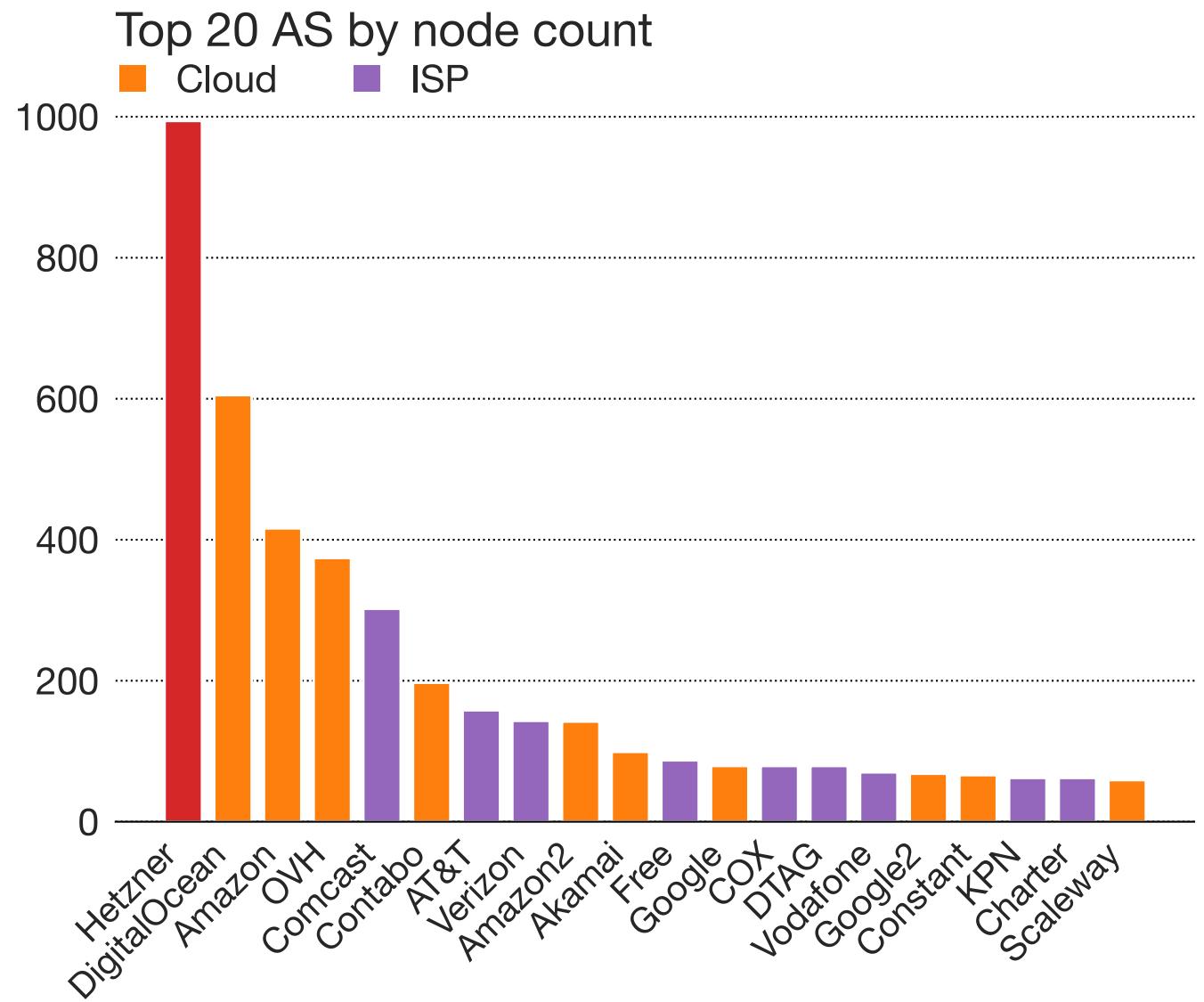
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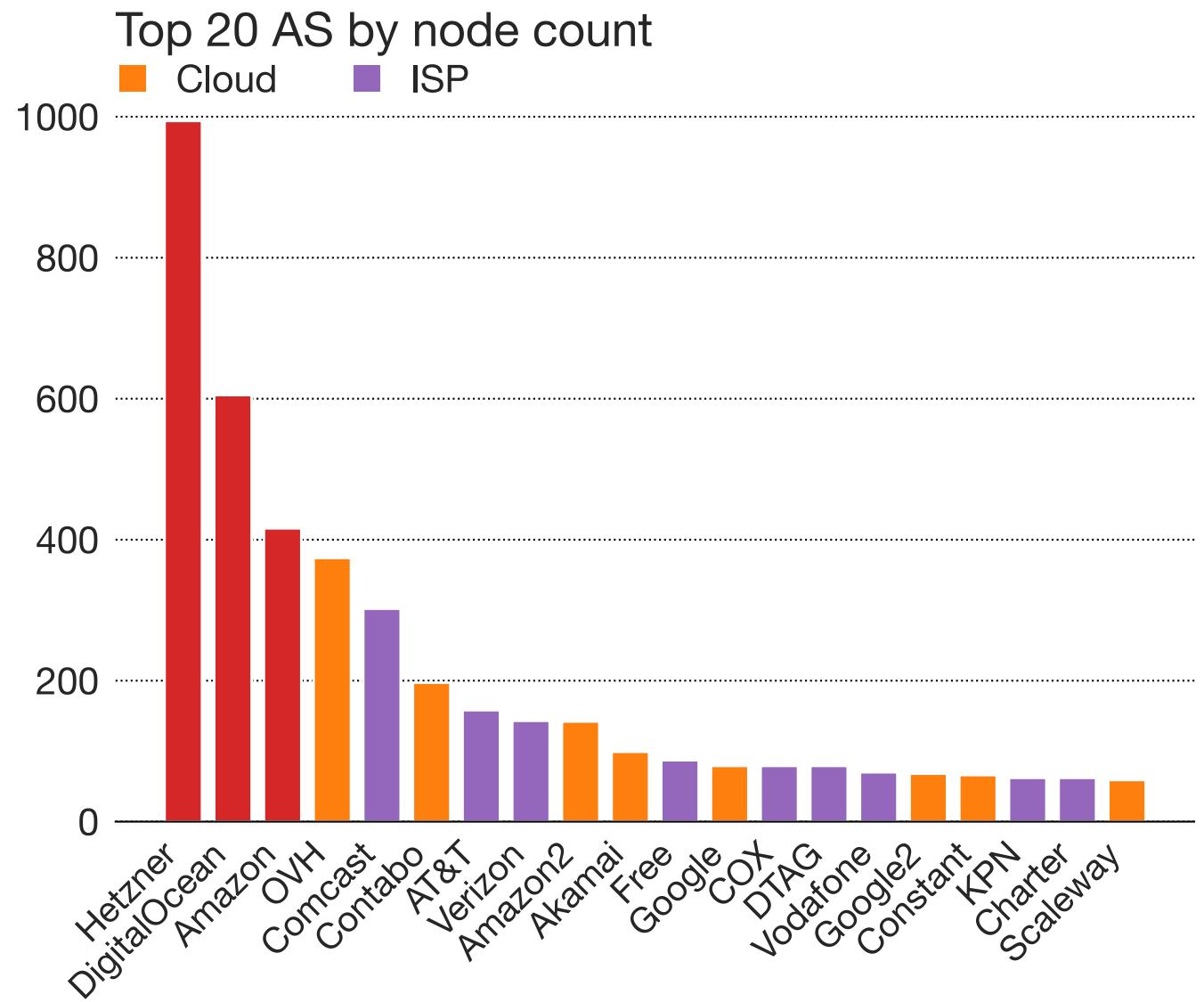
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 - **Hetzner** hosts **12.8%** of nodes
 - **Three** providers host **25% of nodes**



Insights 2: Autonomous systems & ASMAP

- AS-based attacks

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Smaller ISP

5.5.0.0/16



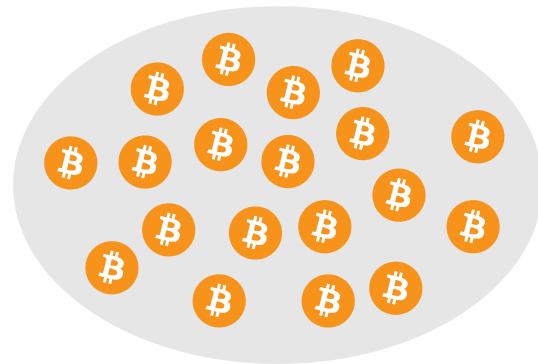
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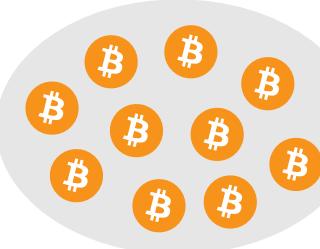
Google

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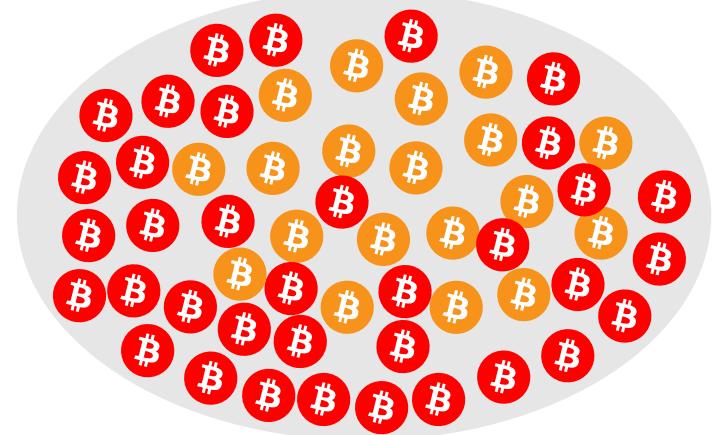
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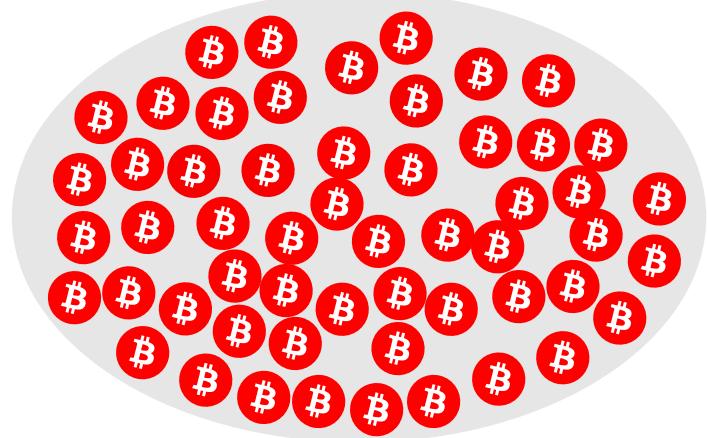
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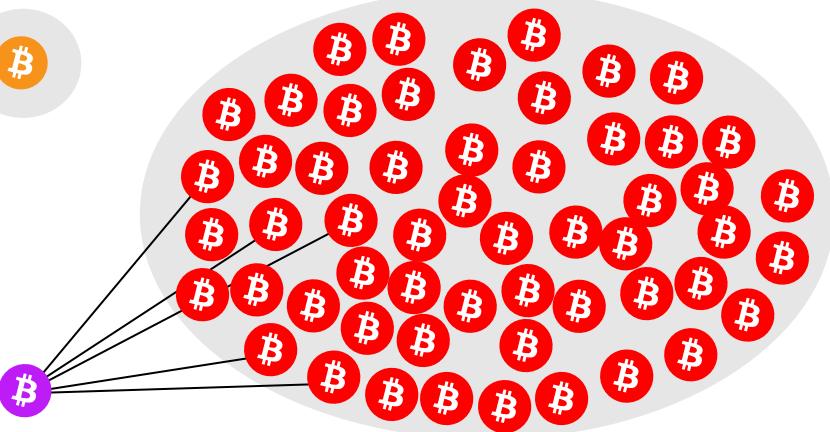
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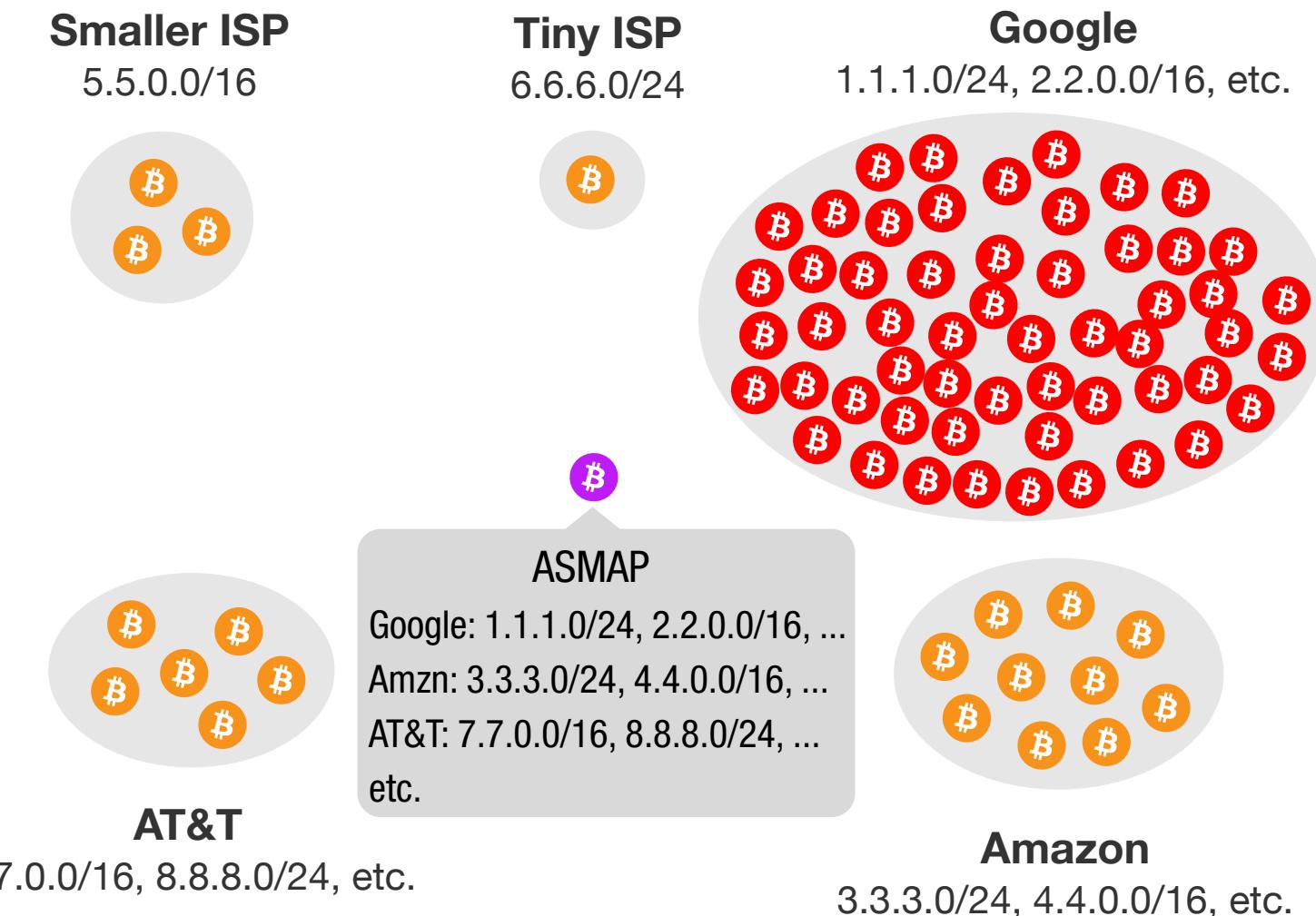


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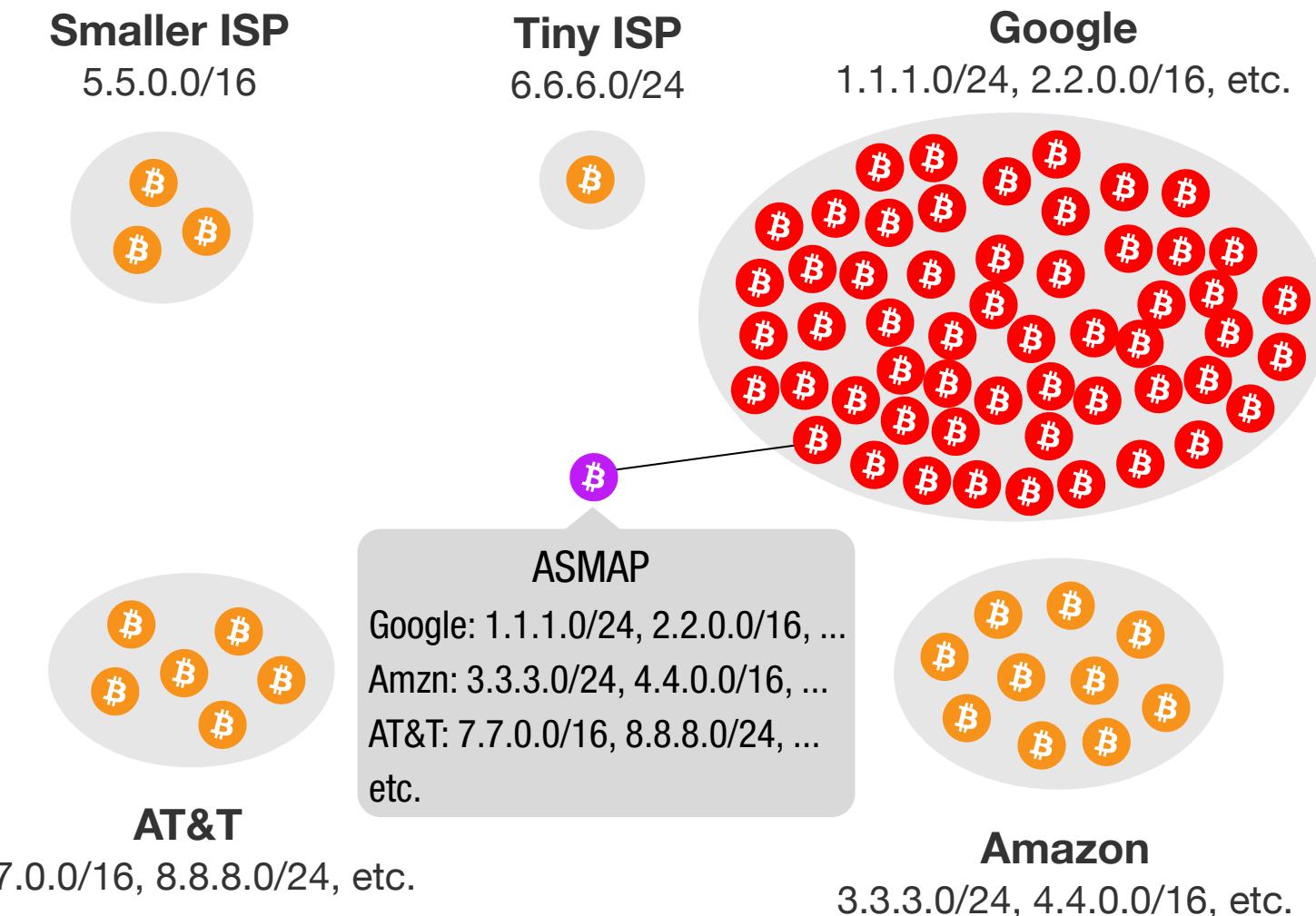
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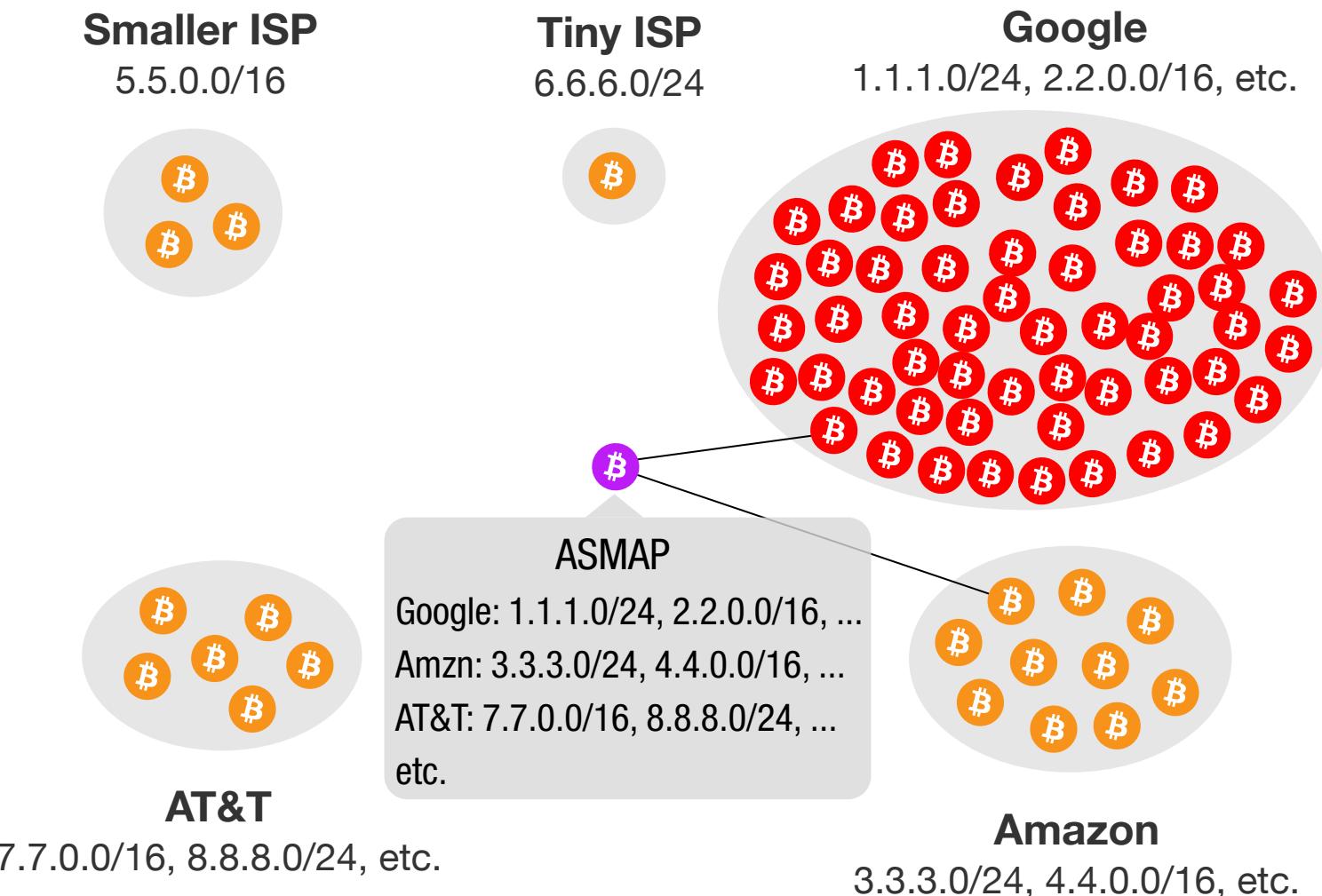
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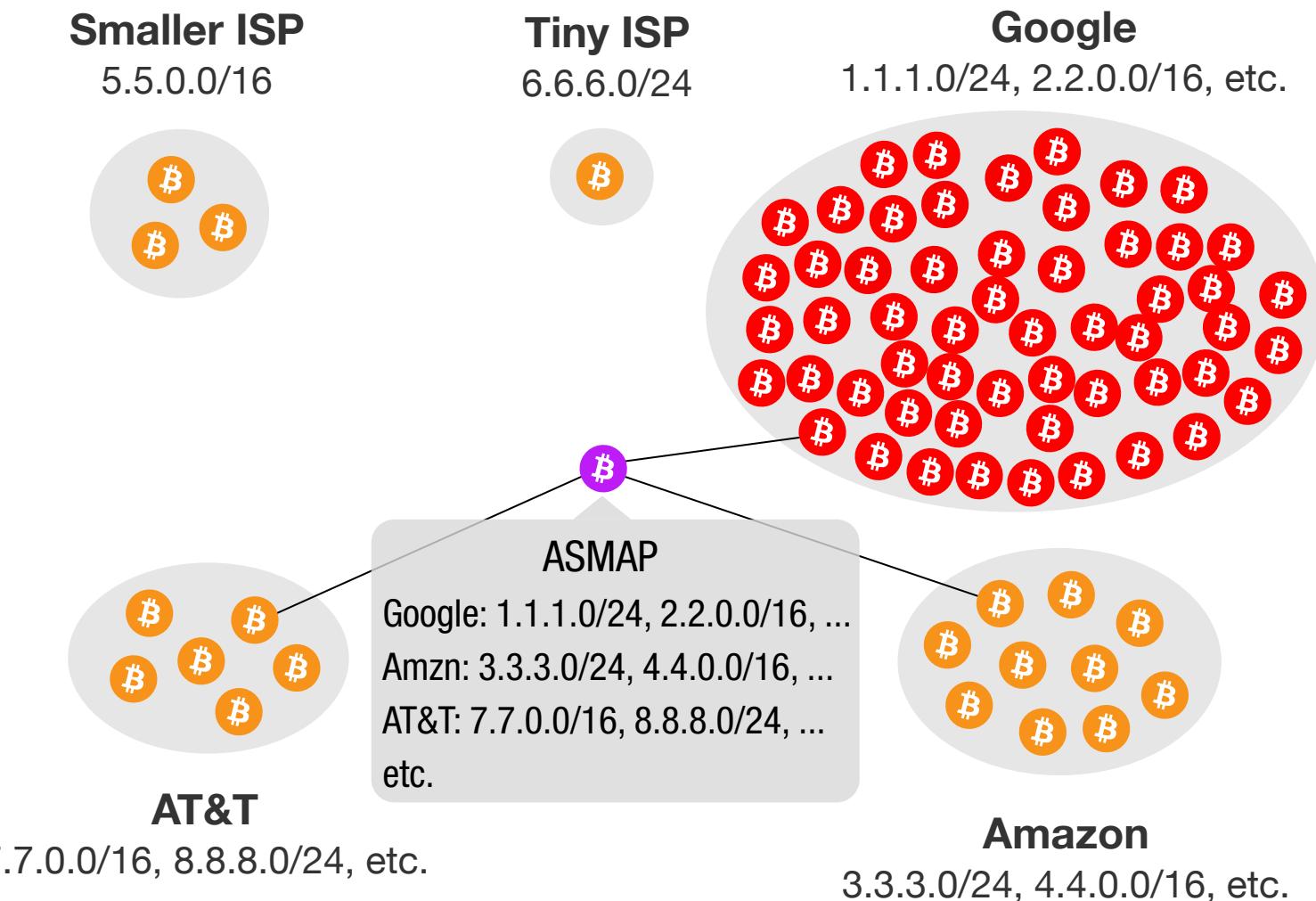
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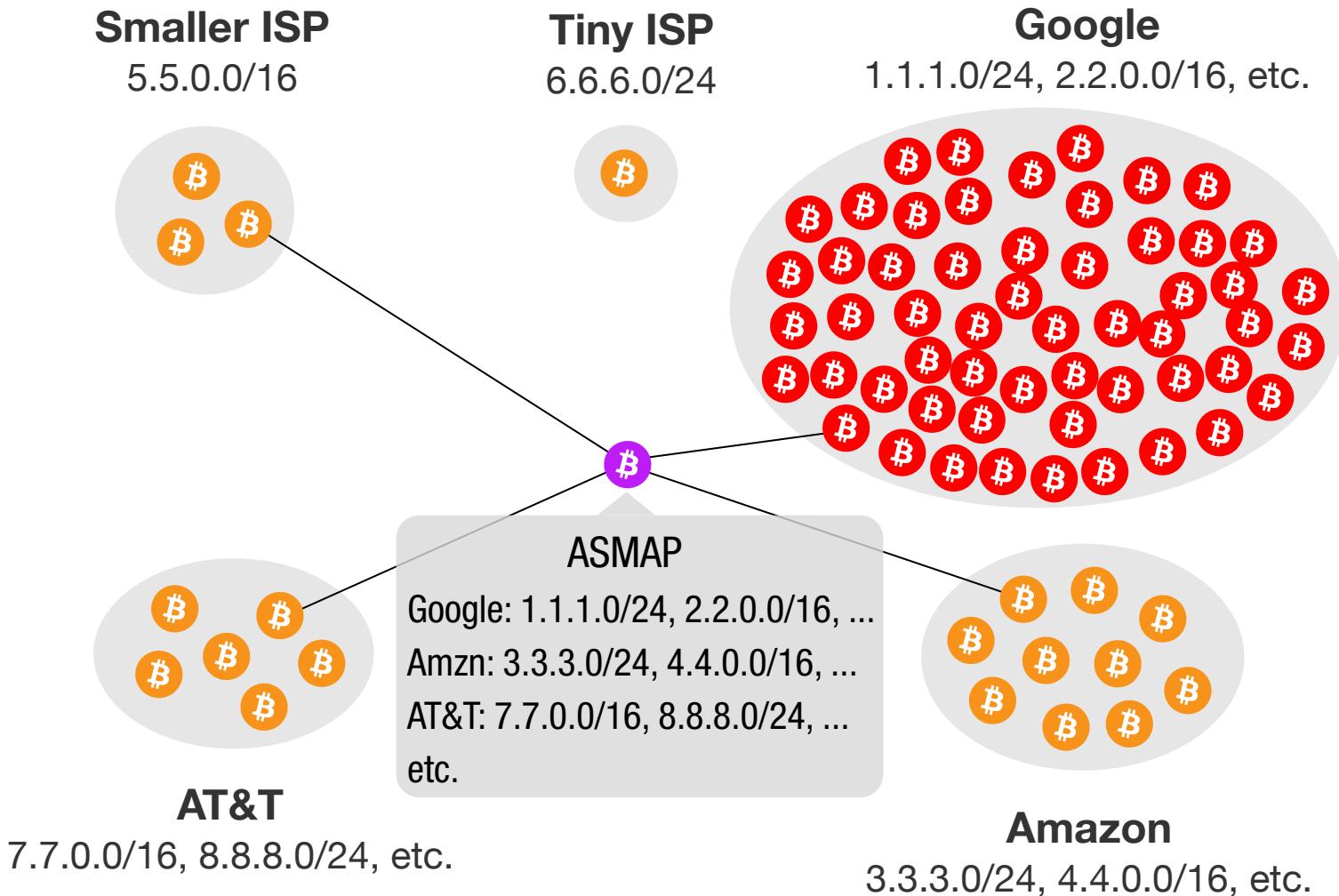
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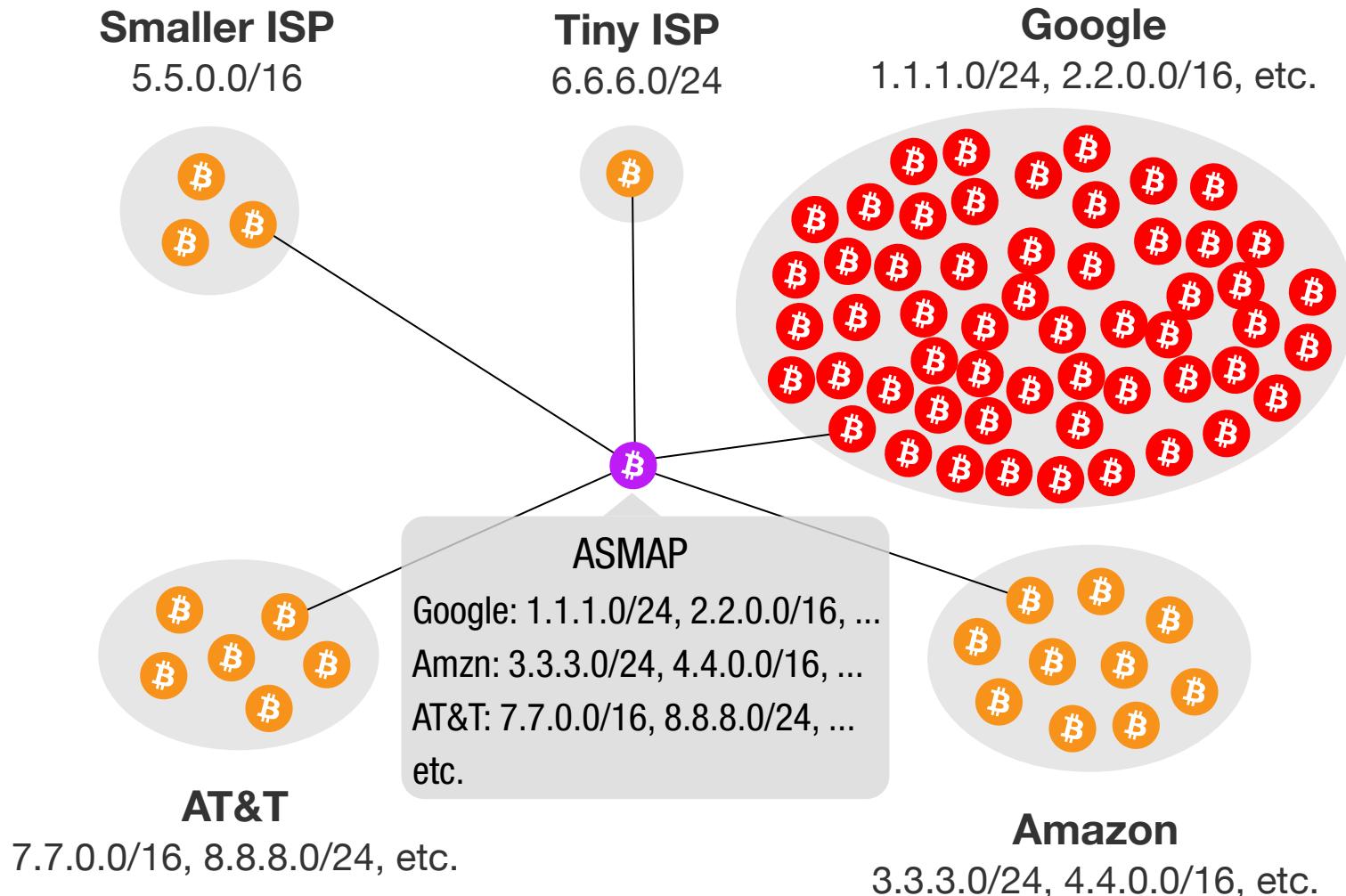
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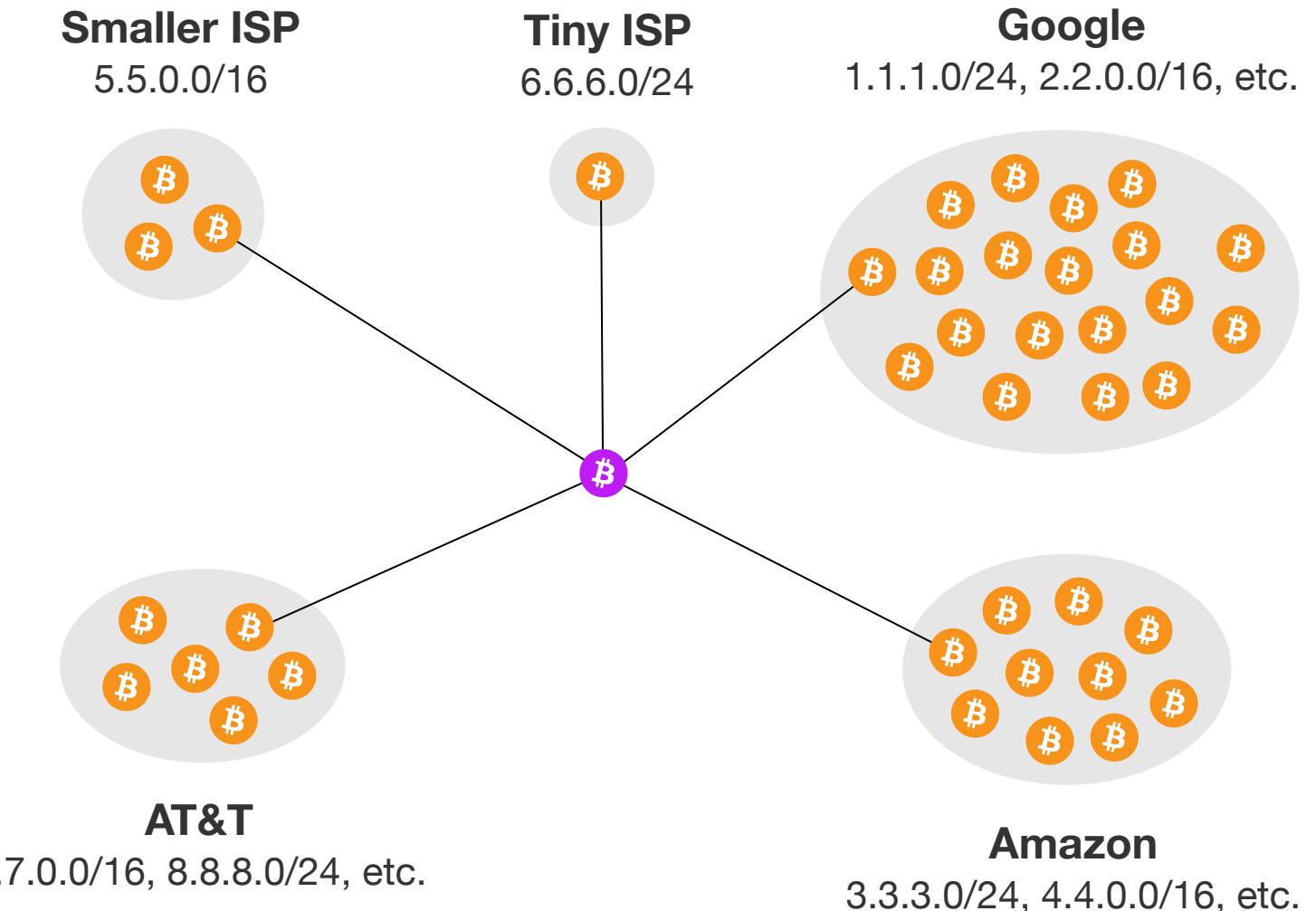
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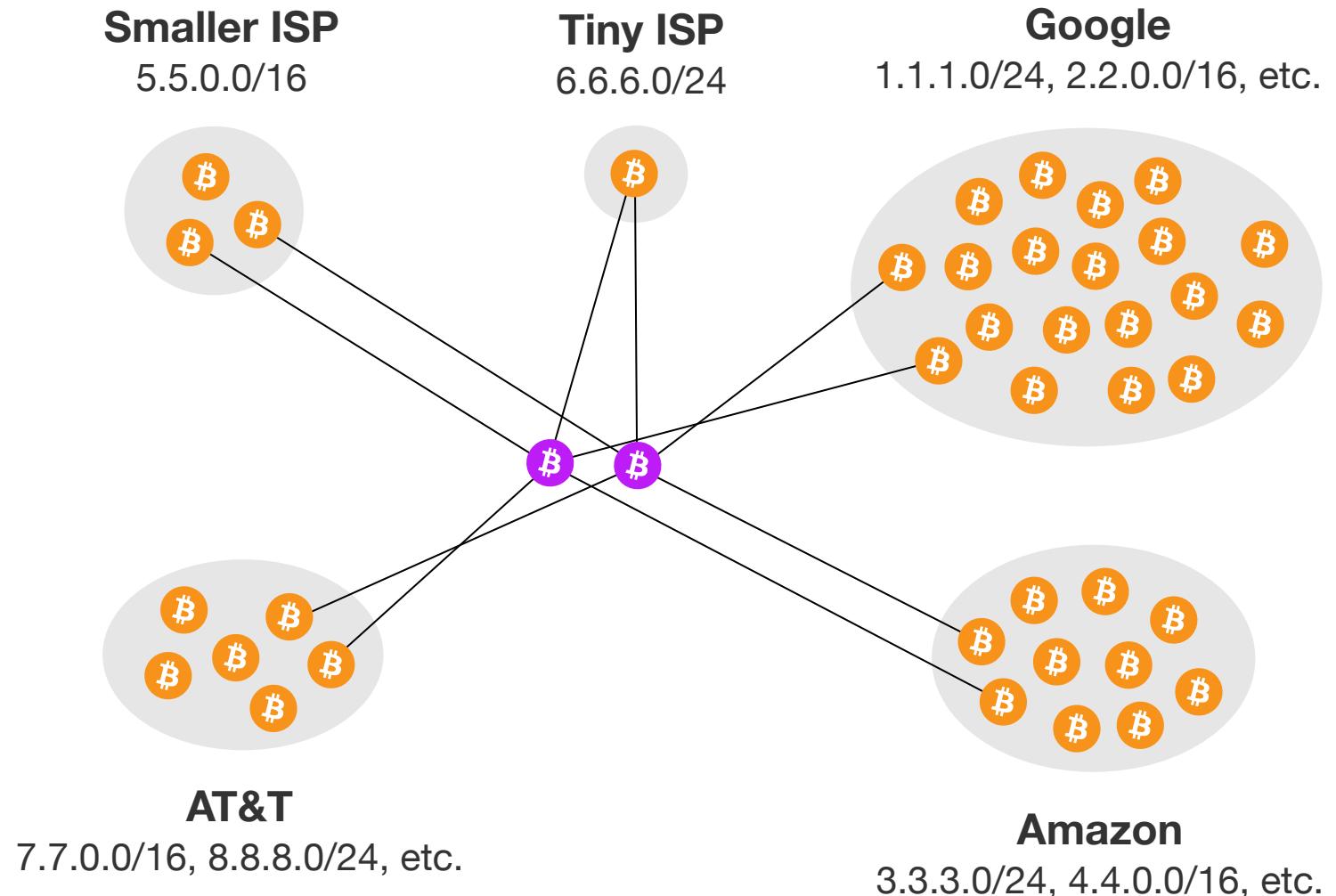
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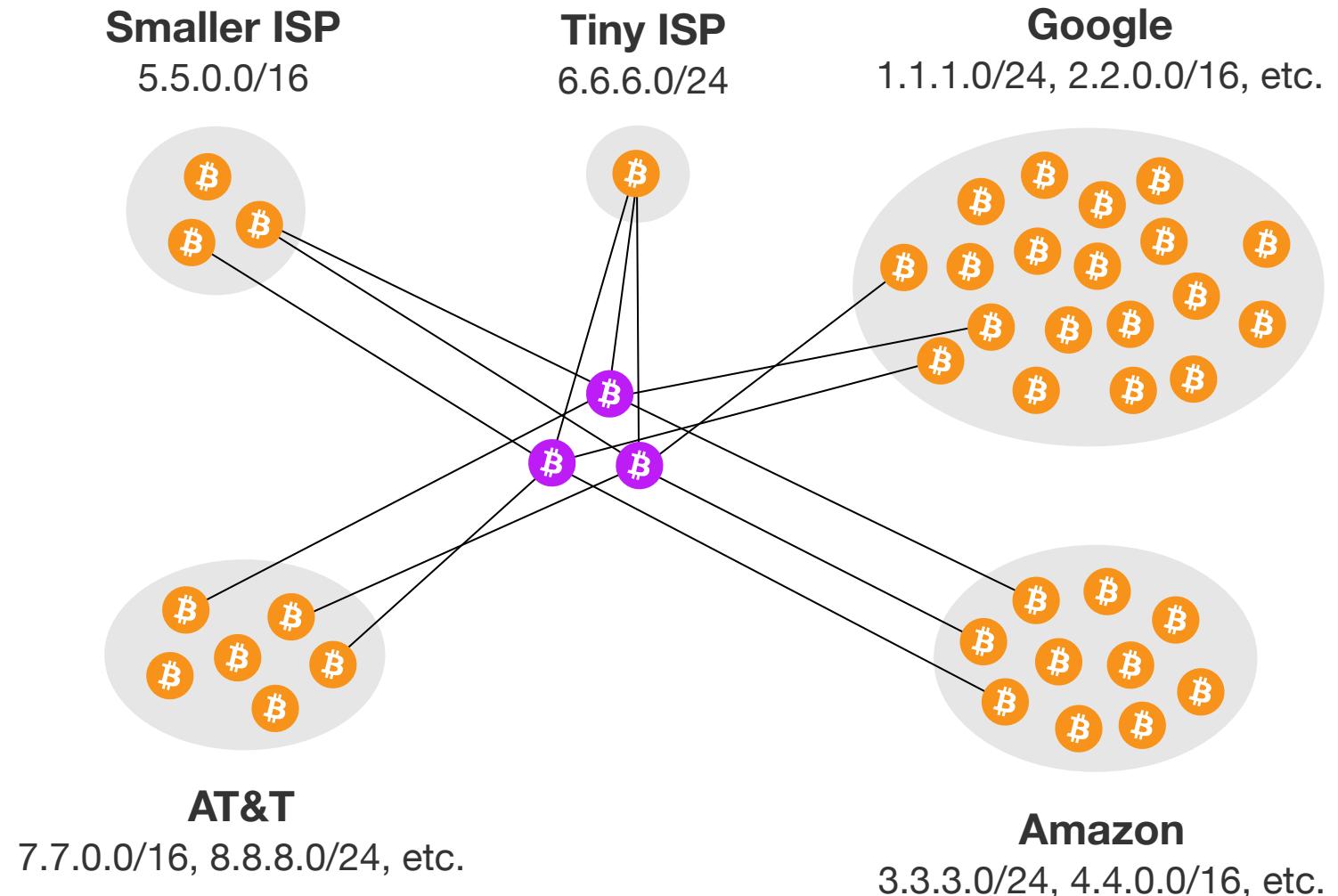
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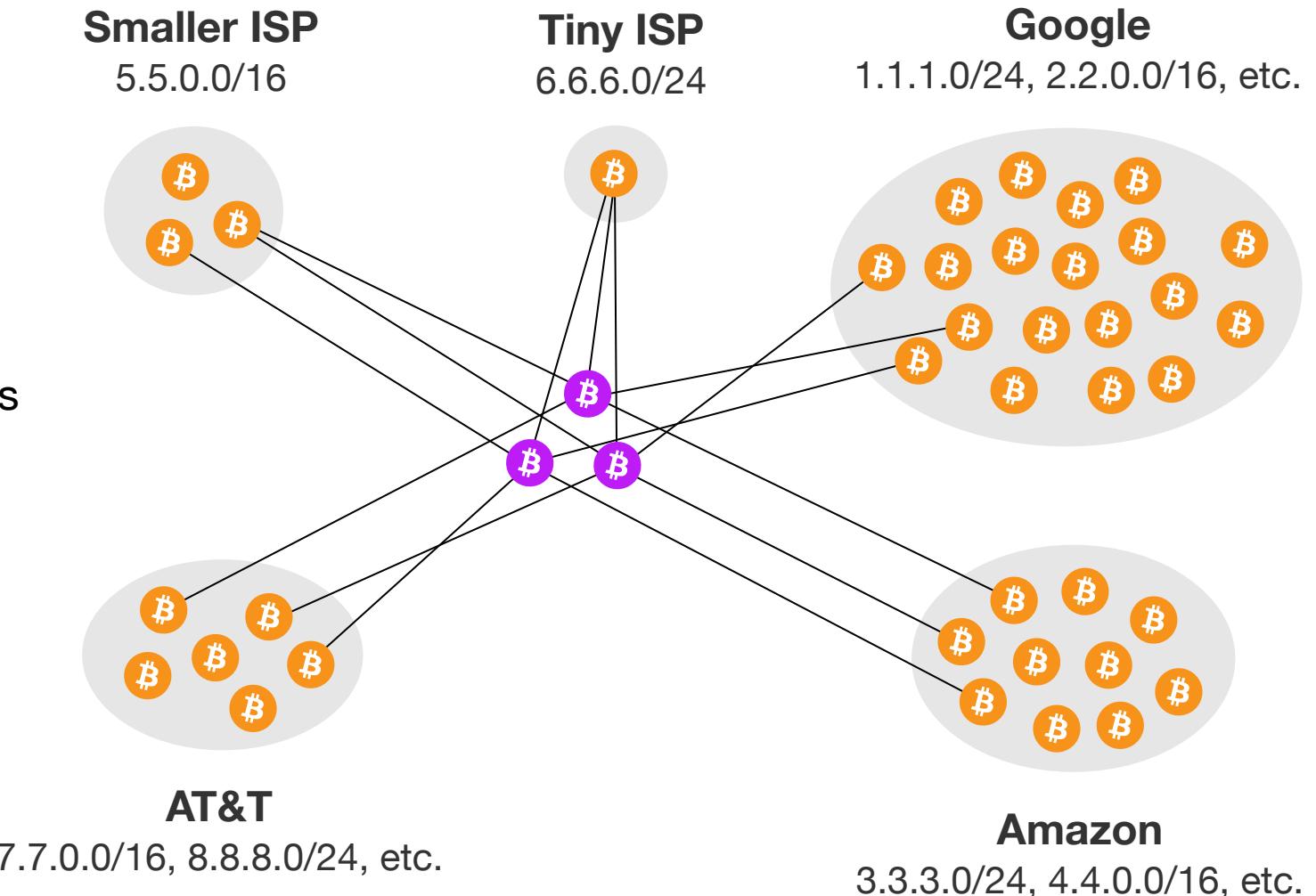
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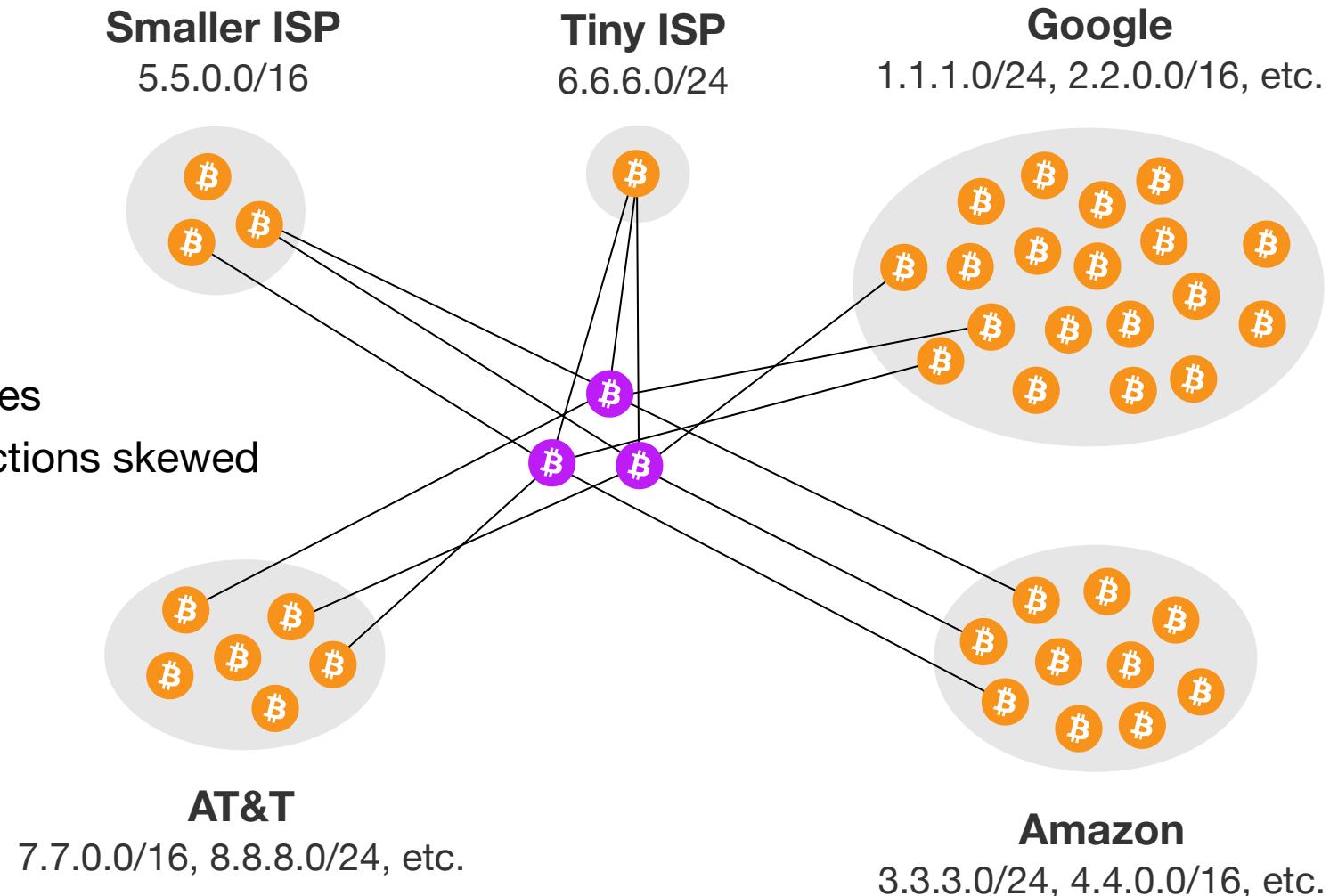
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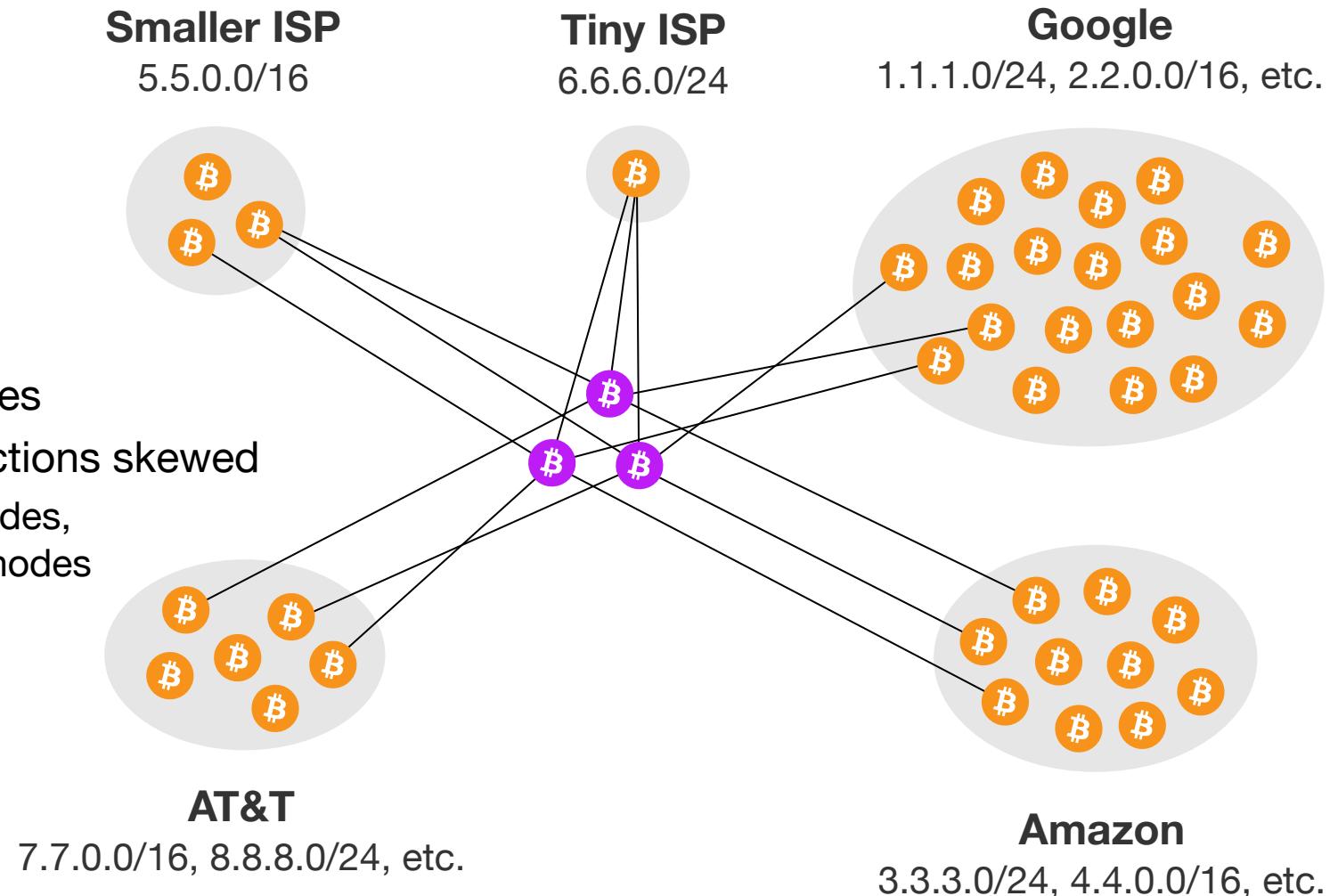
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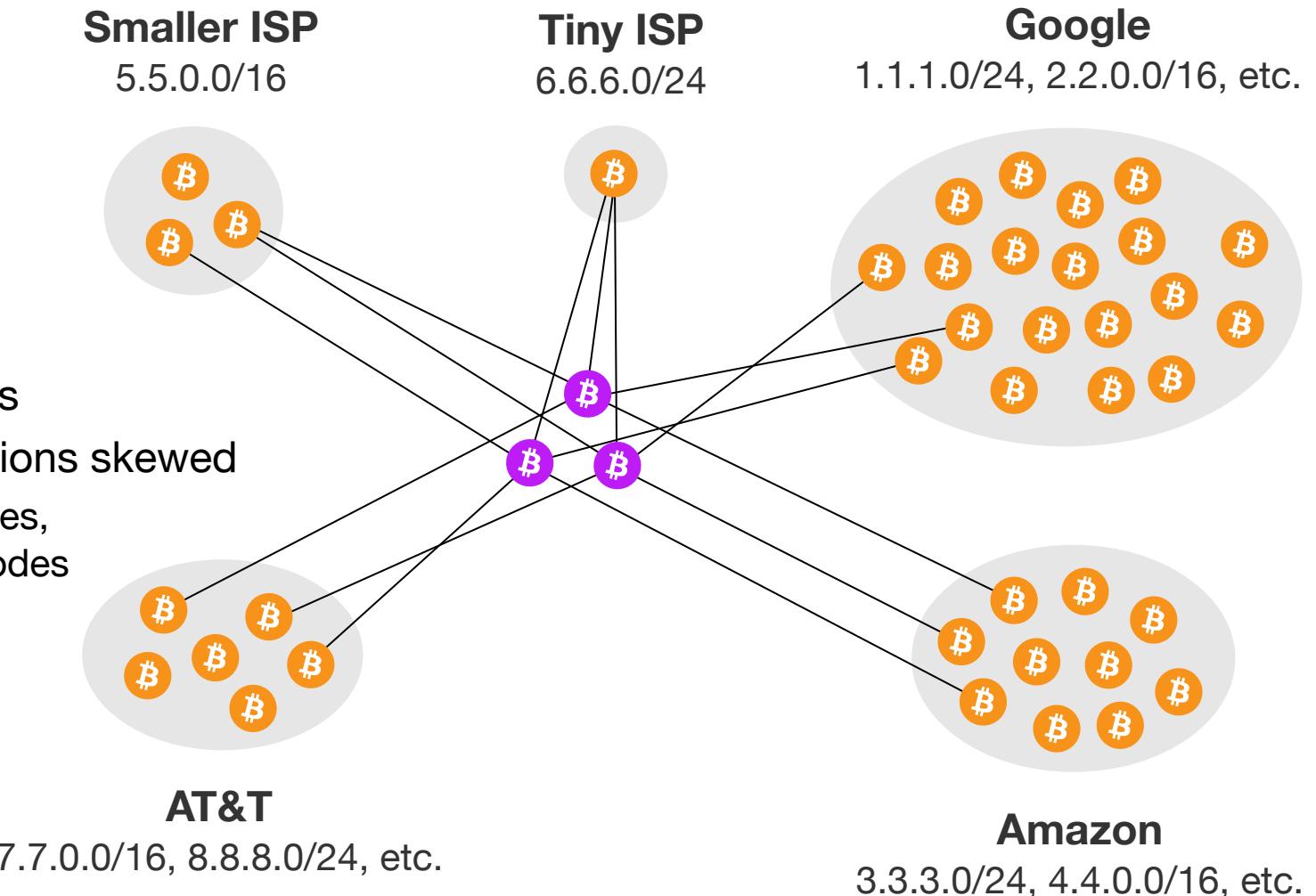
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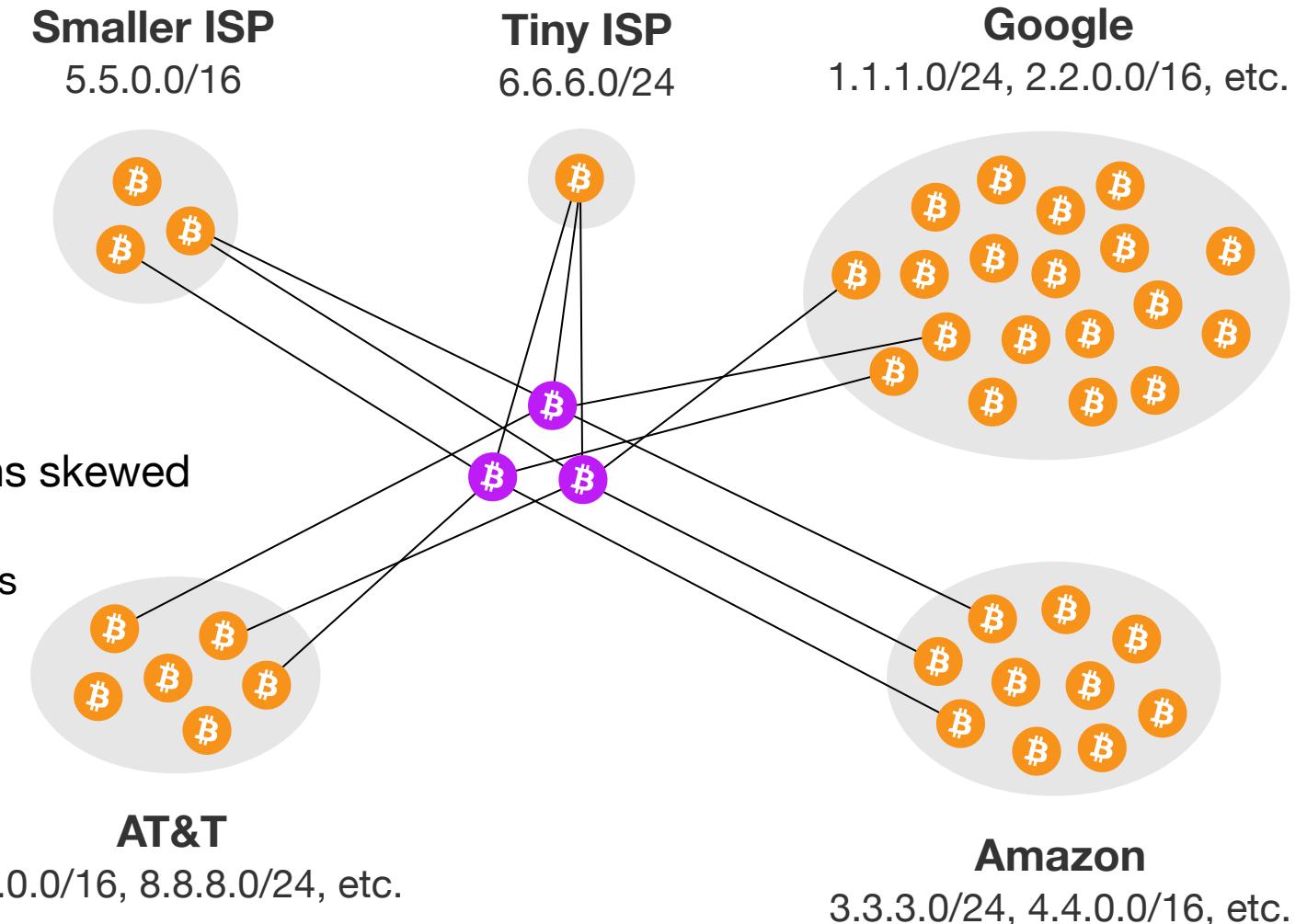
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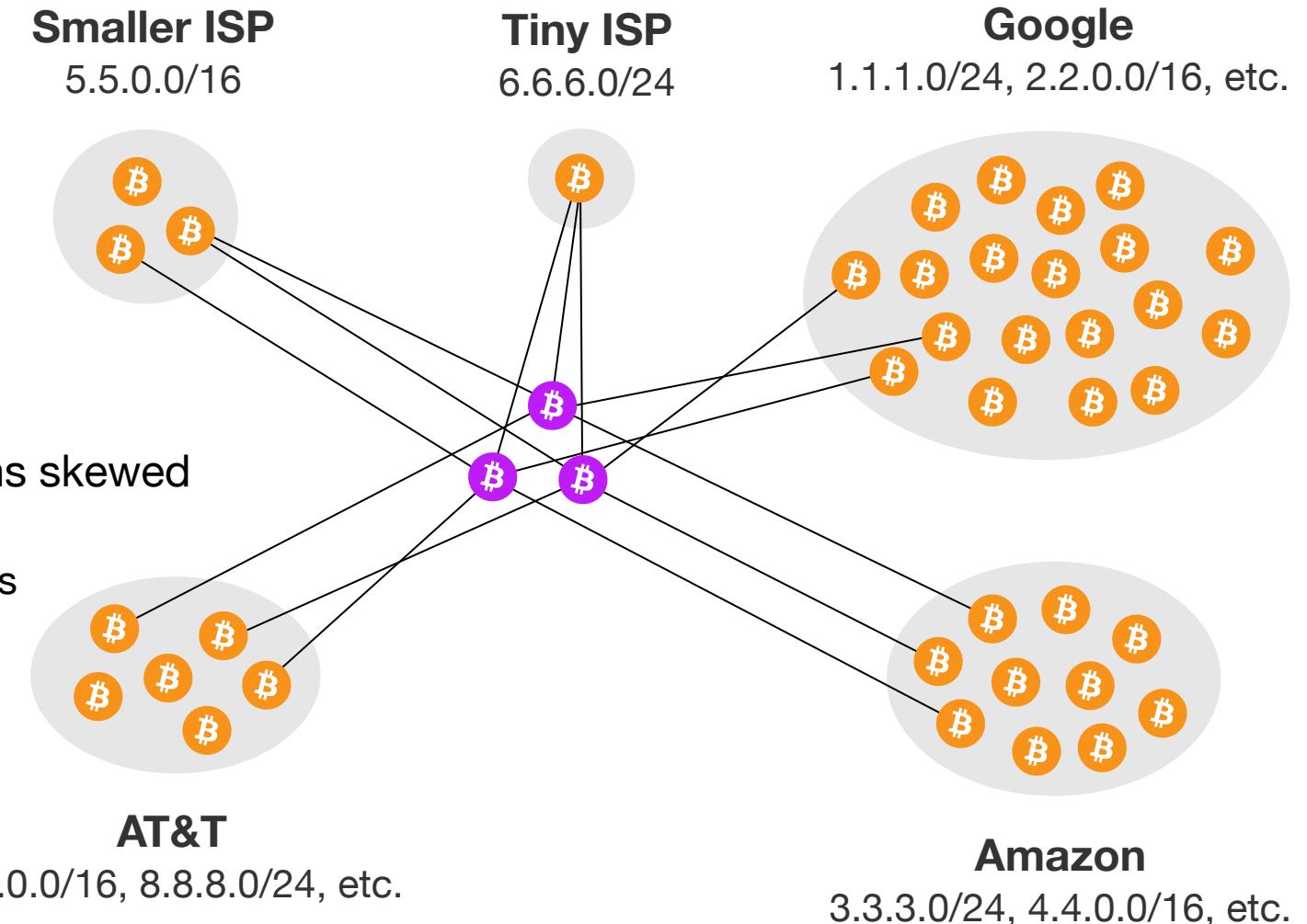
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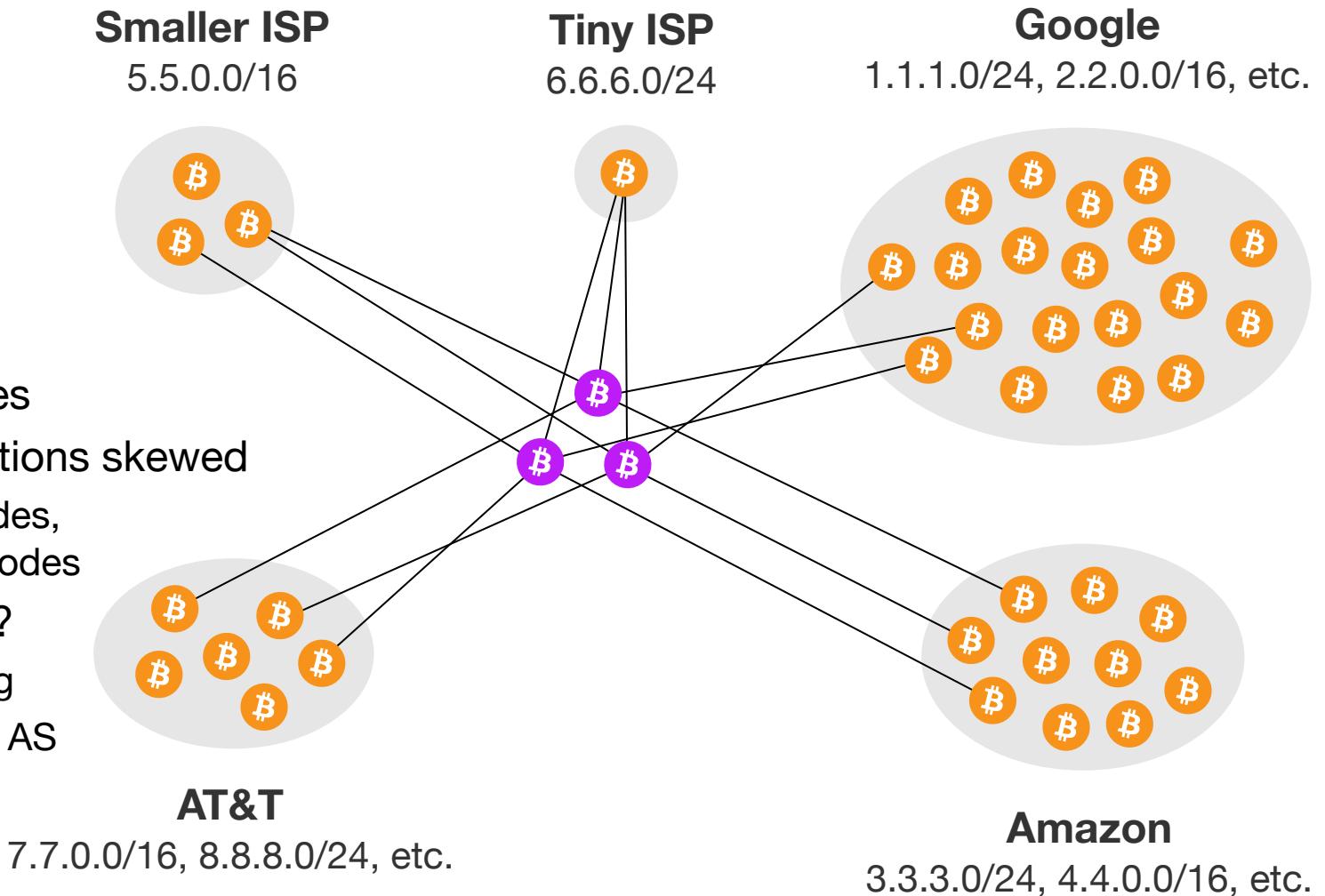
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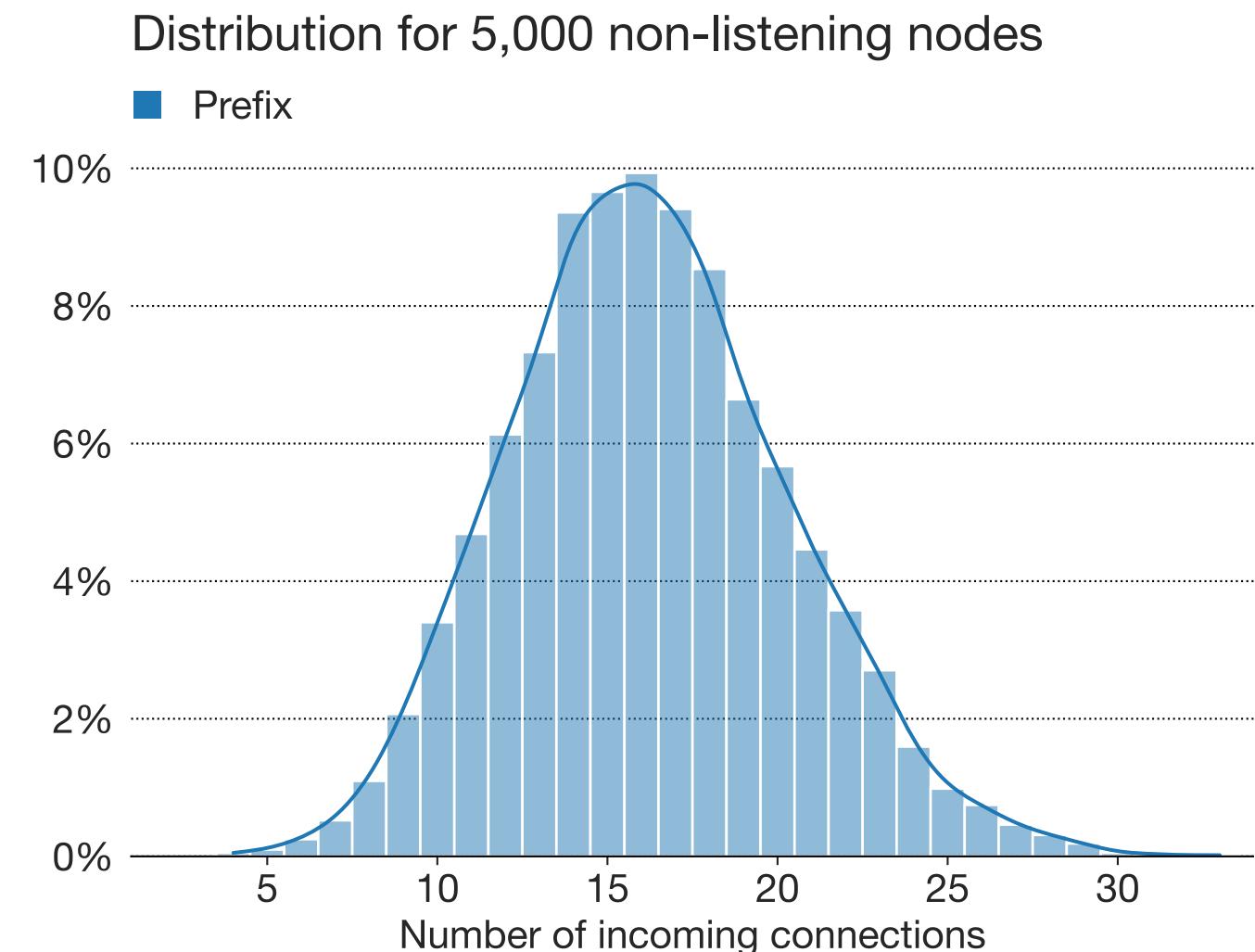
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 - Higher load for nodes in small AS
 - Network cohesion



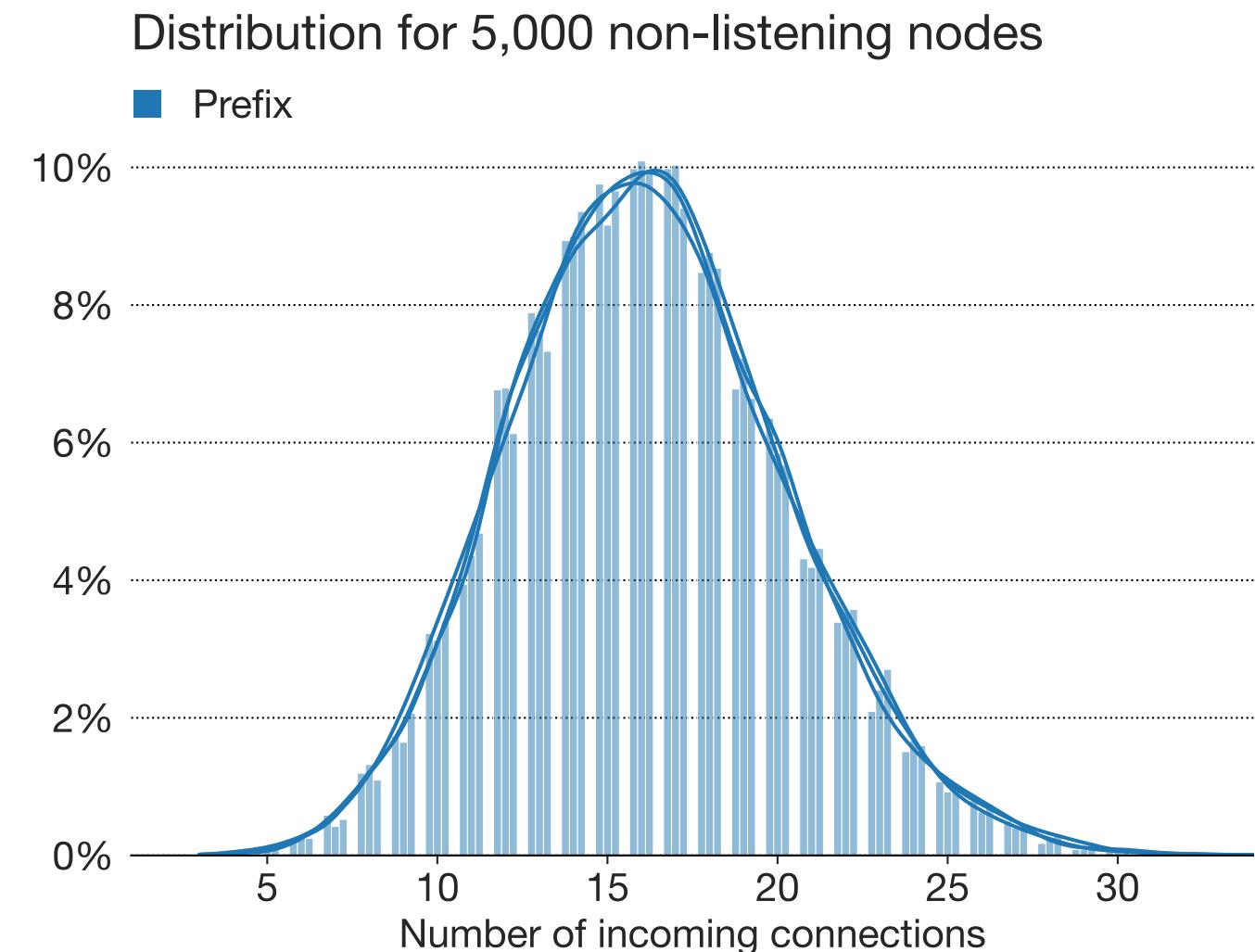
Insights 2: Autonomous systems & ASMAP: Simulation data

- P2P network simulator



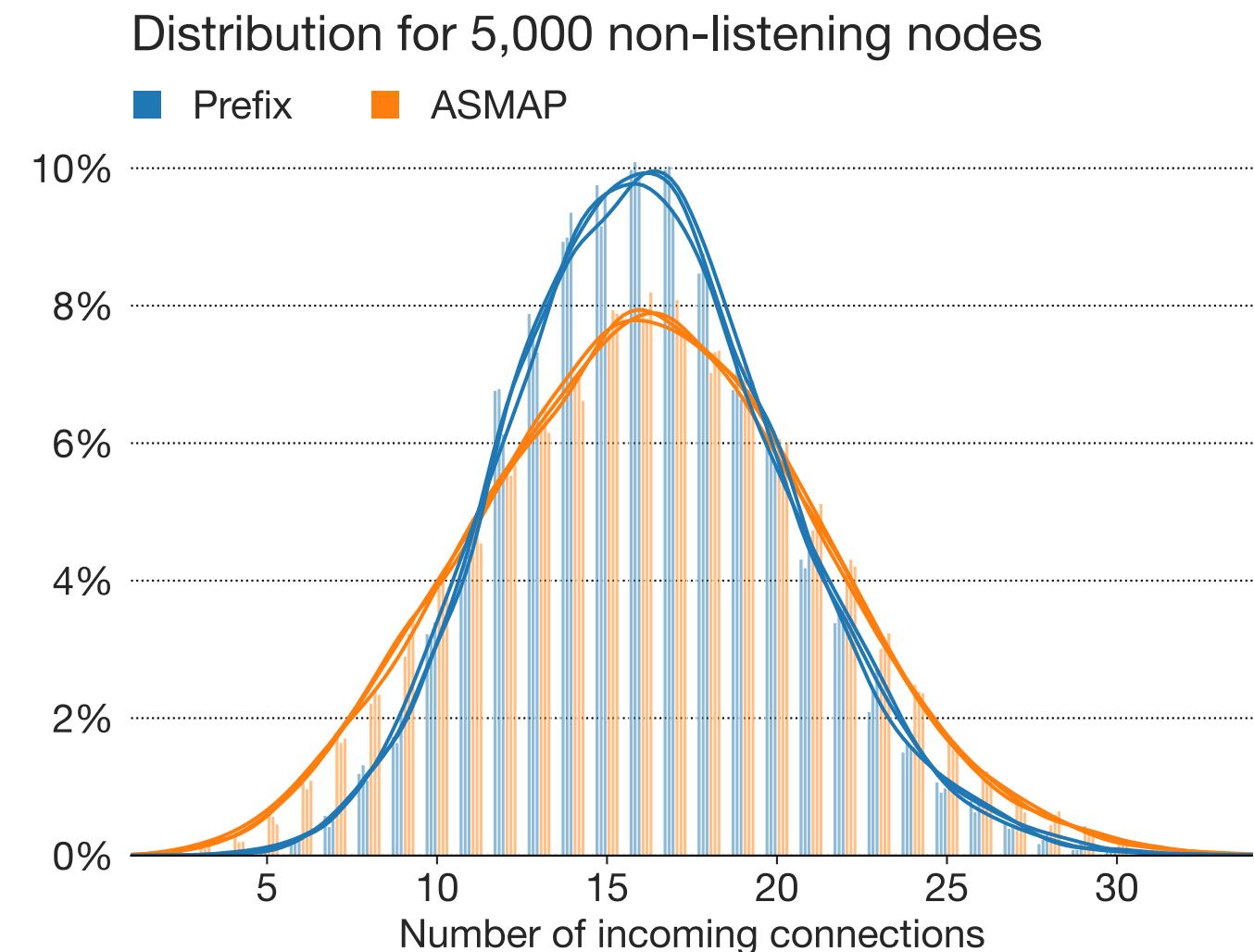
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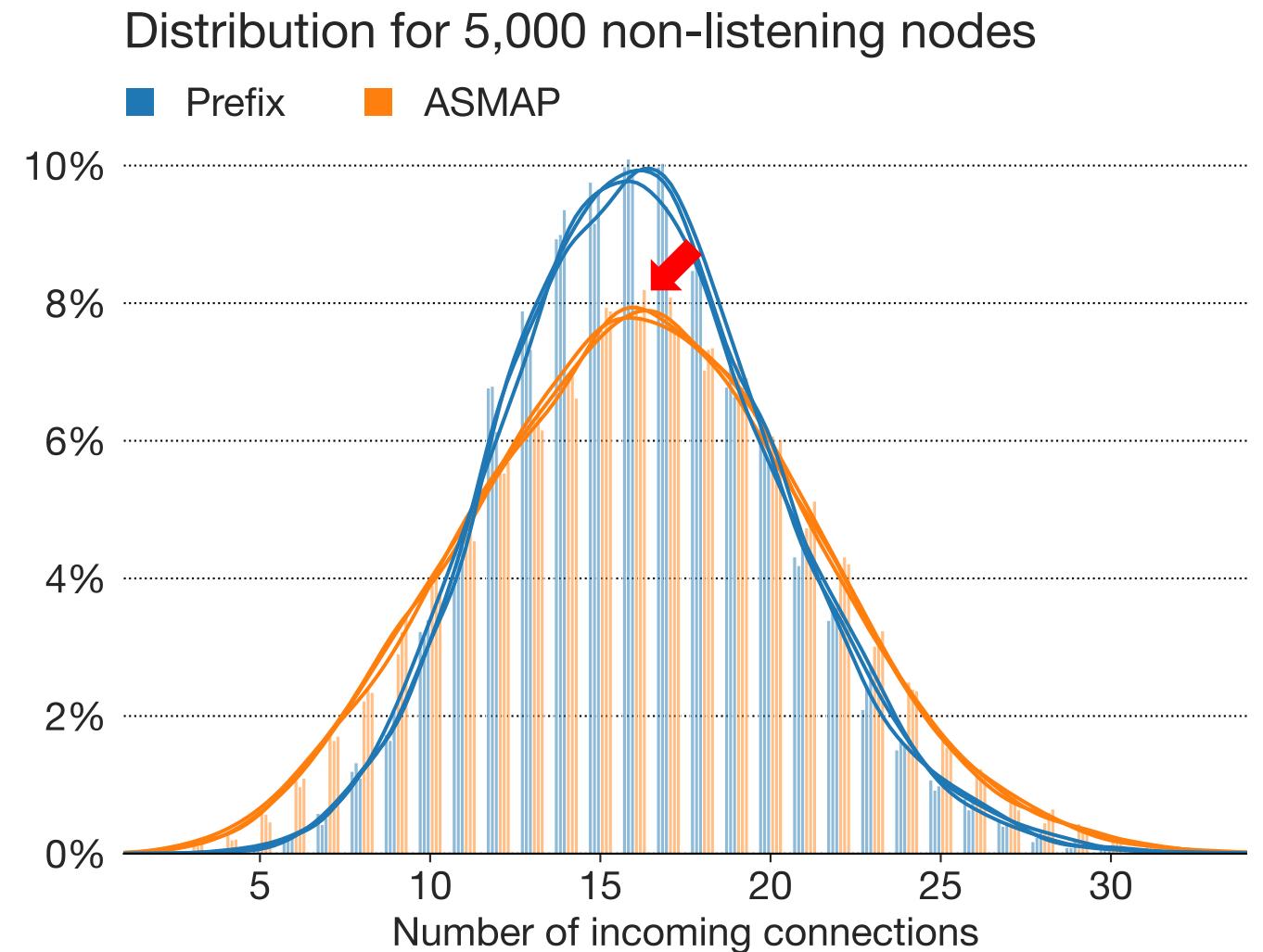
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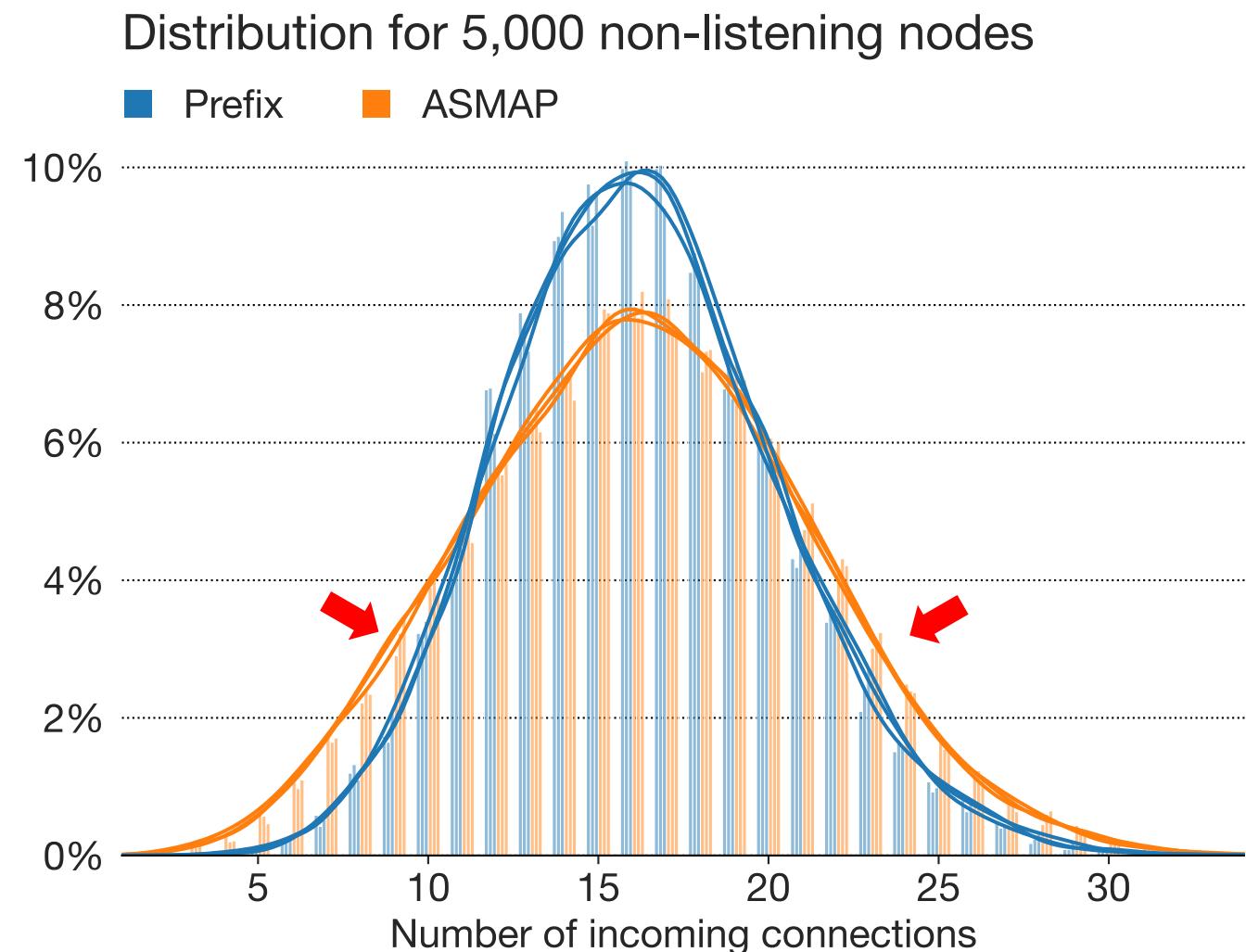
Insights 2: Autonomous systems & ASMAP: Simulation data

- P2P network simulator
- Insights
 - For small n_{nl} : similar μ , larger σ



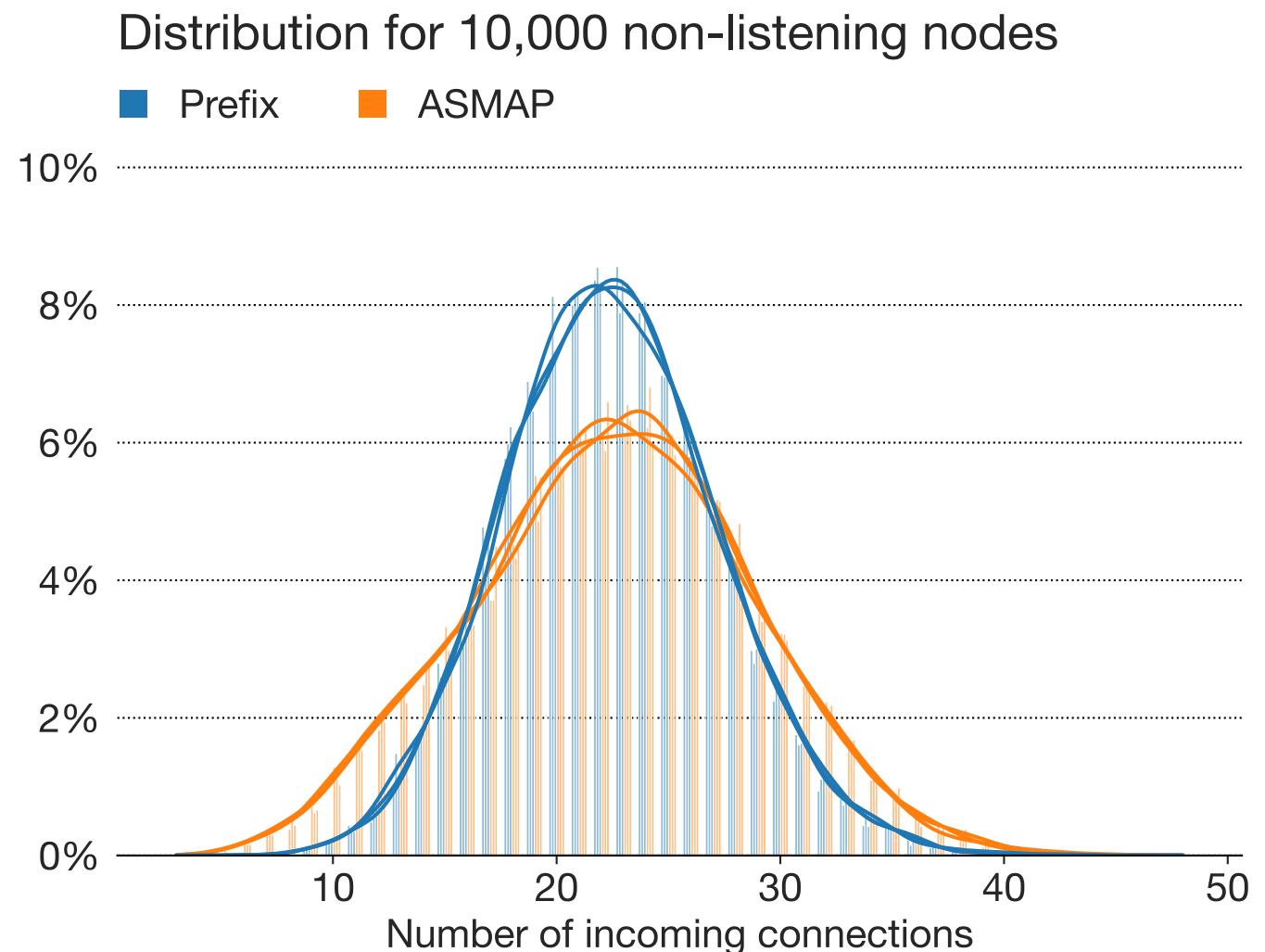
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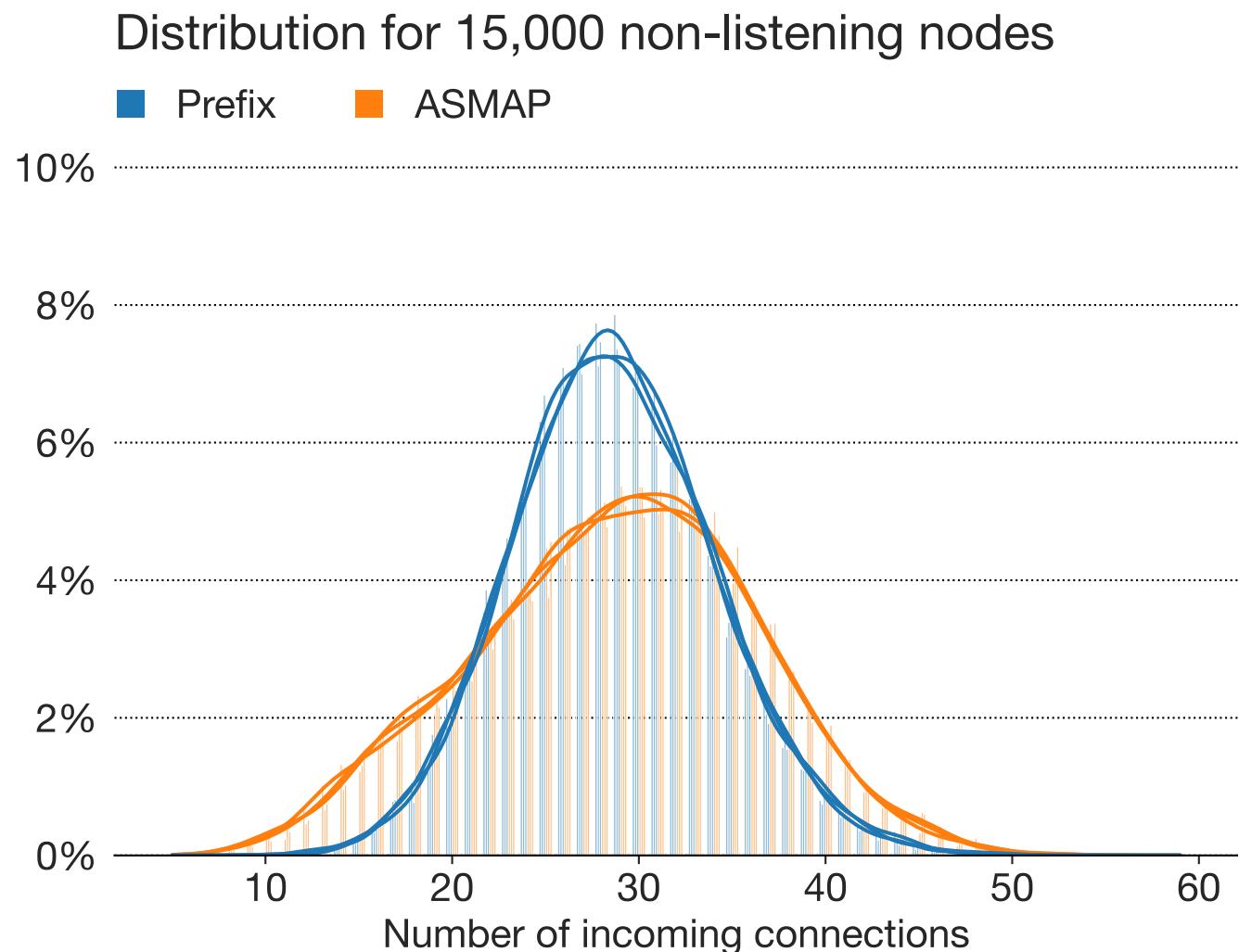
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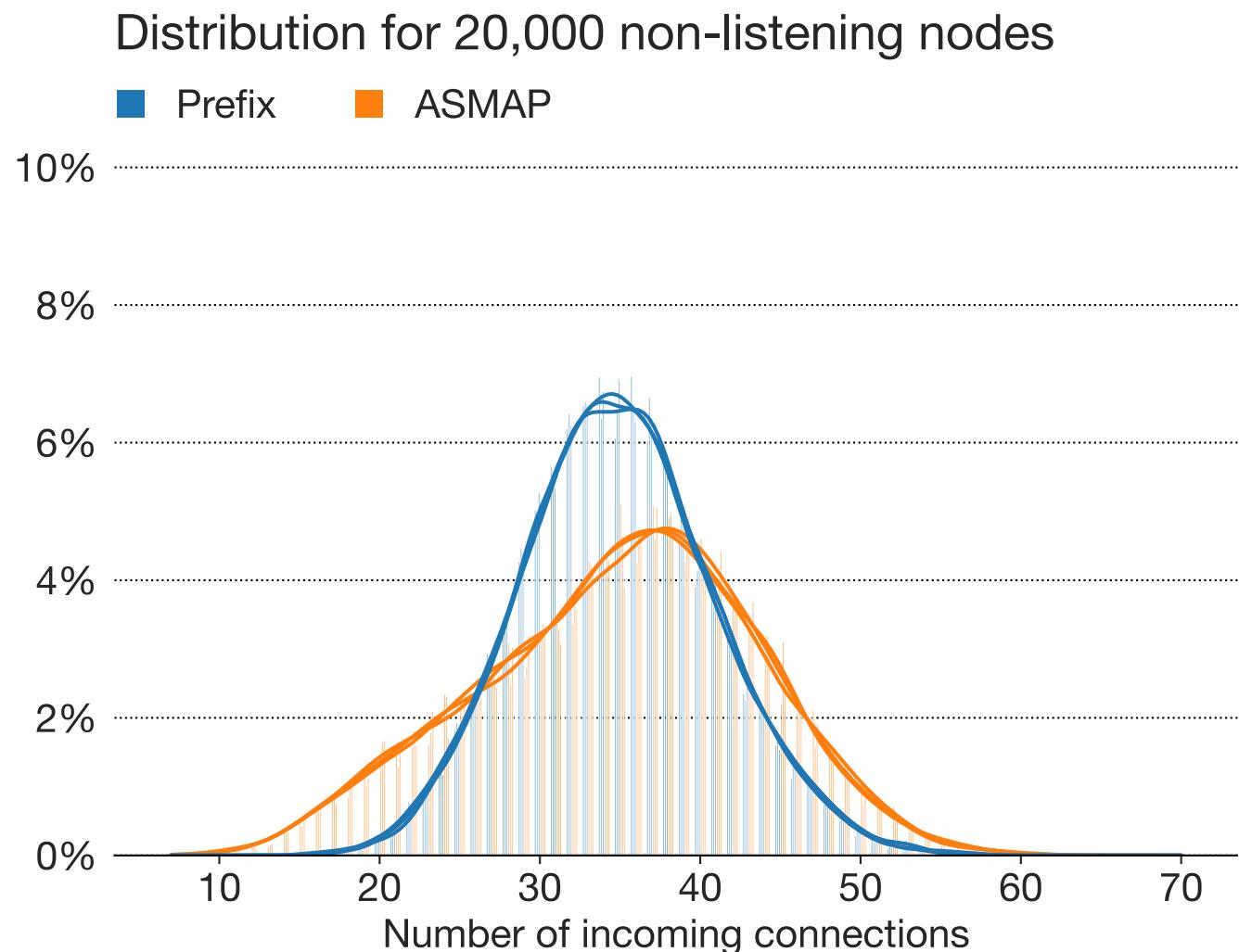
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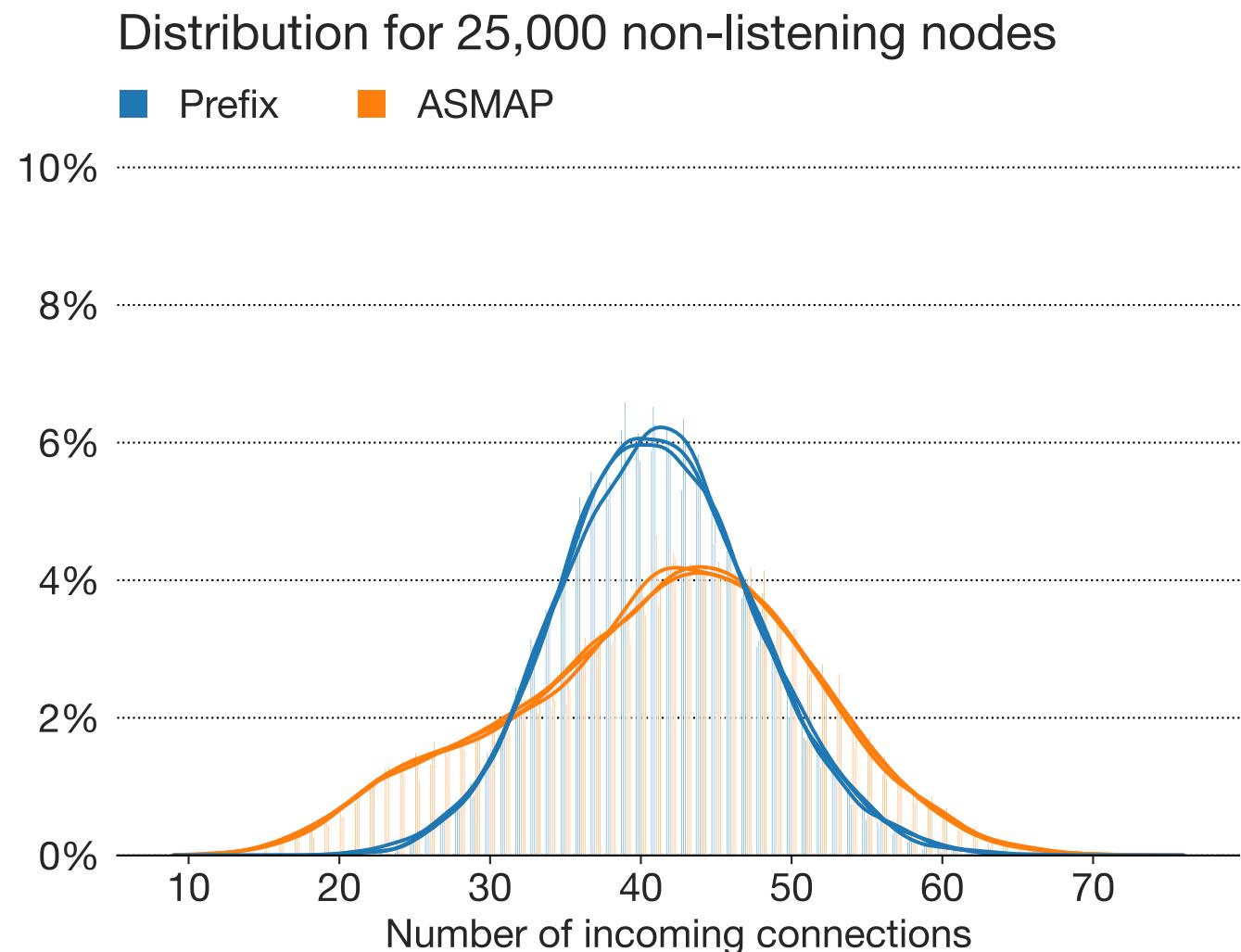
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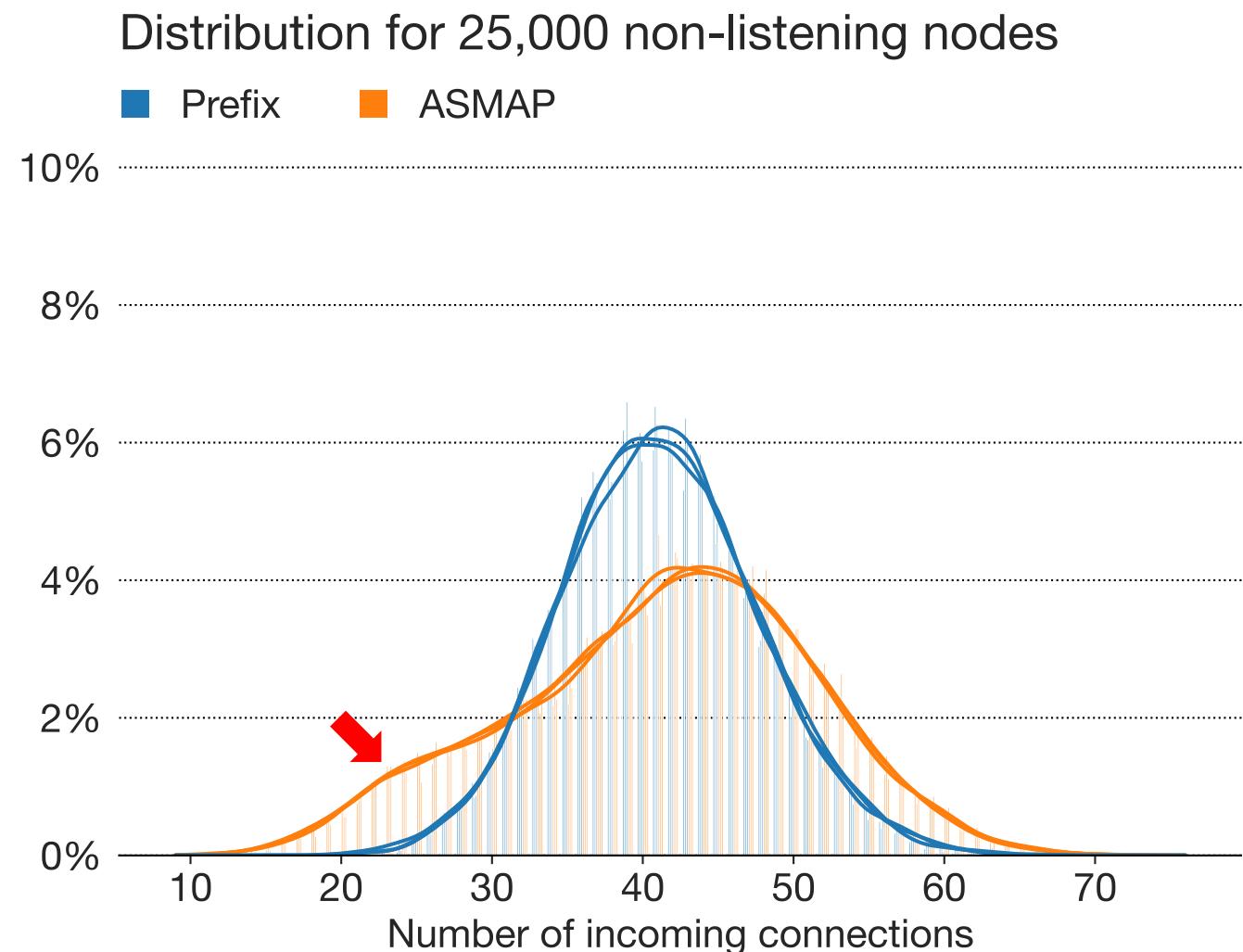
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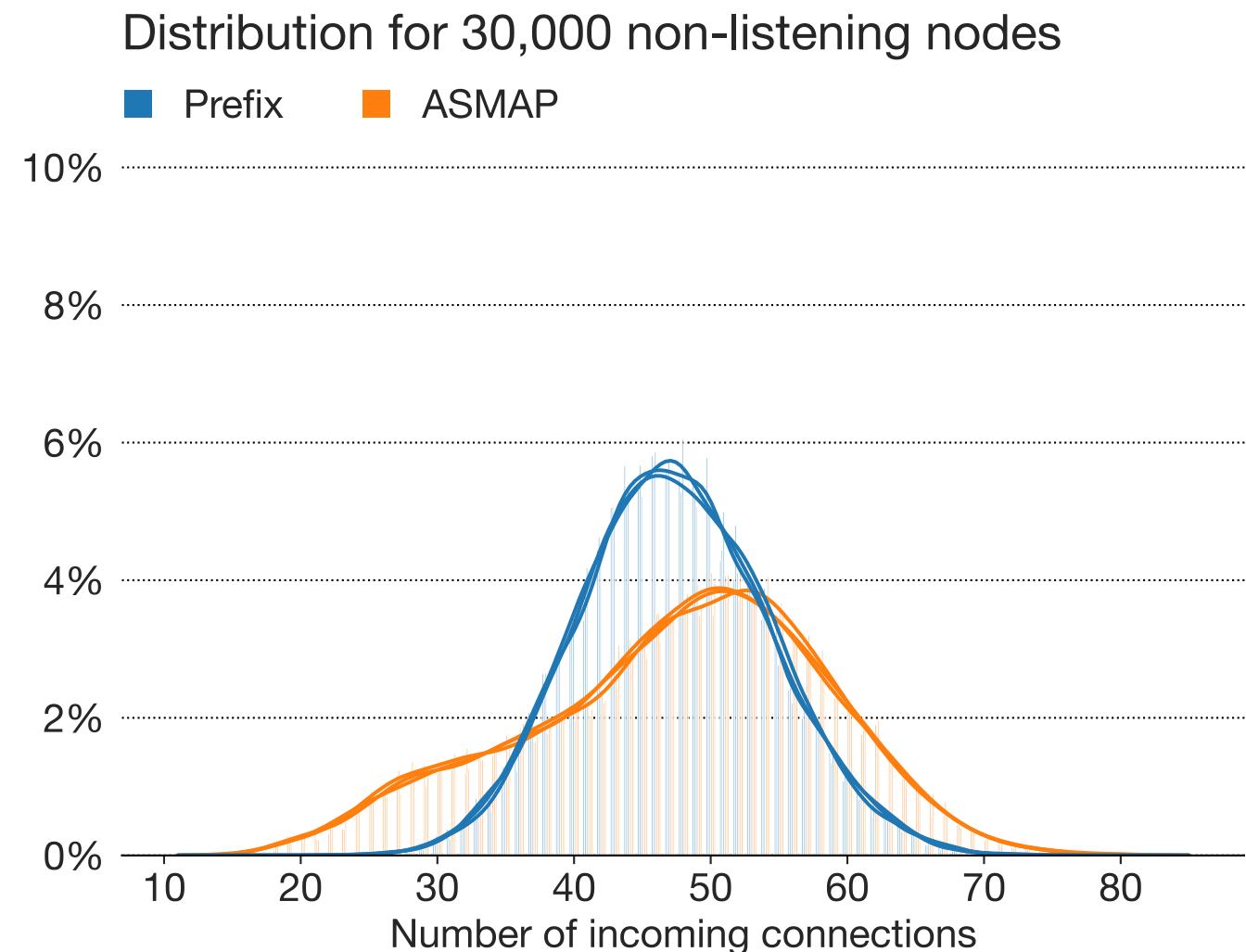
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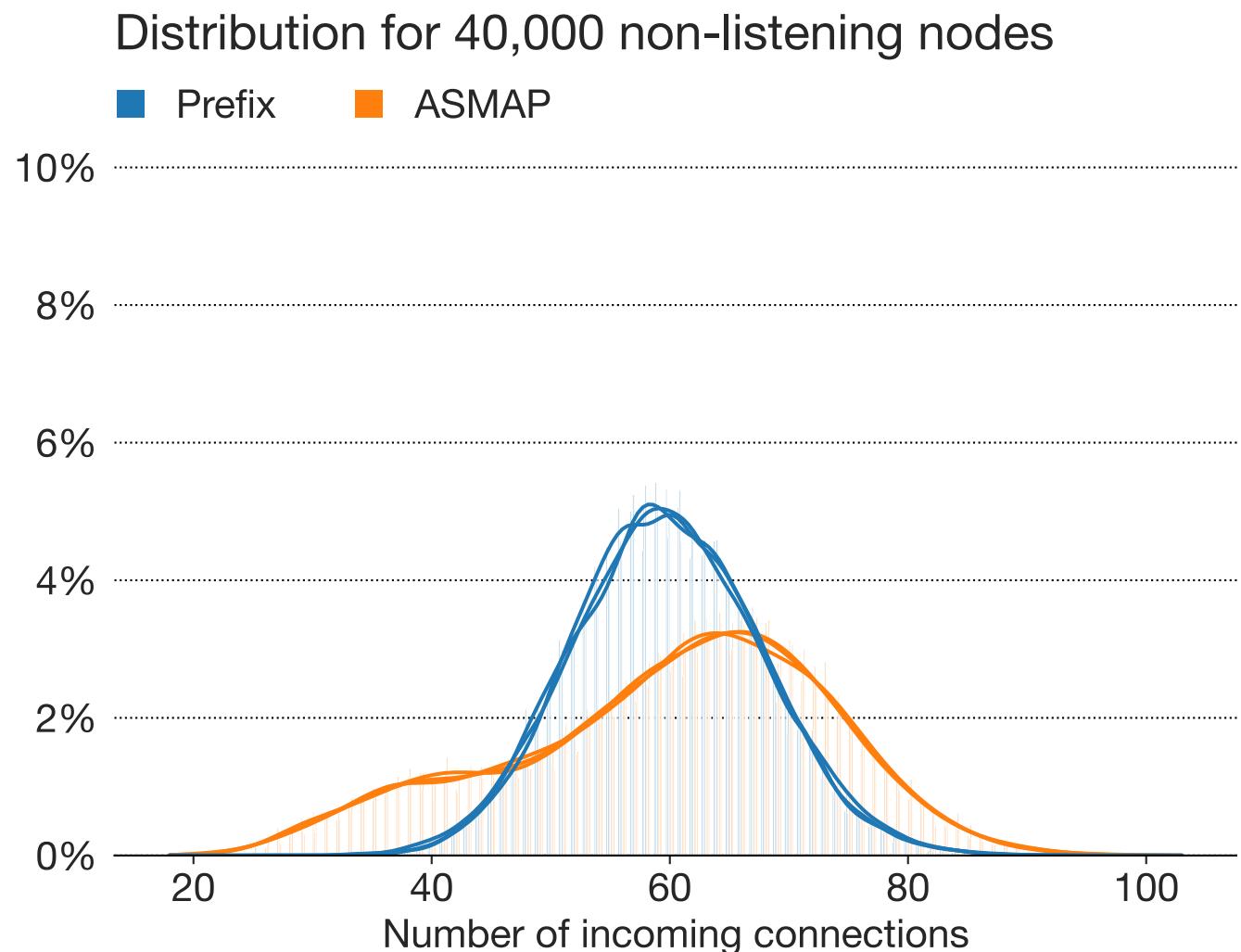
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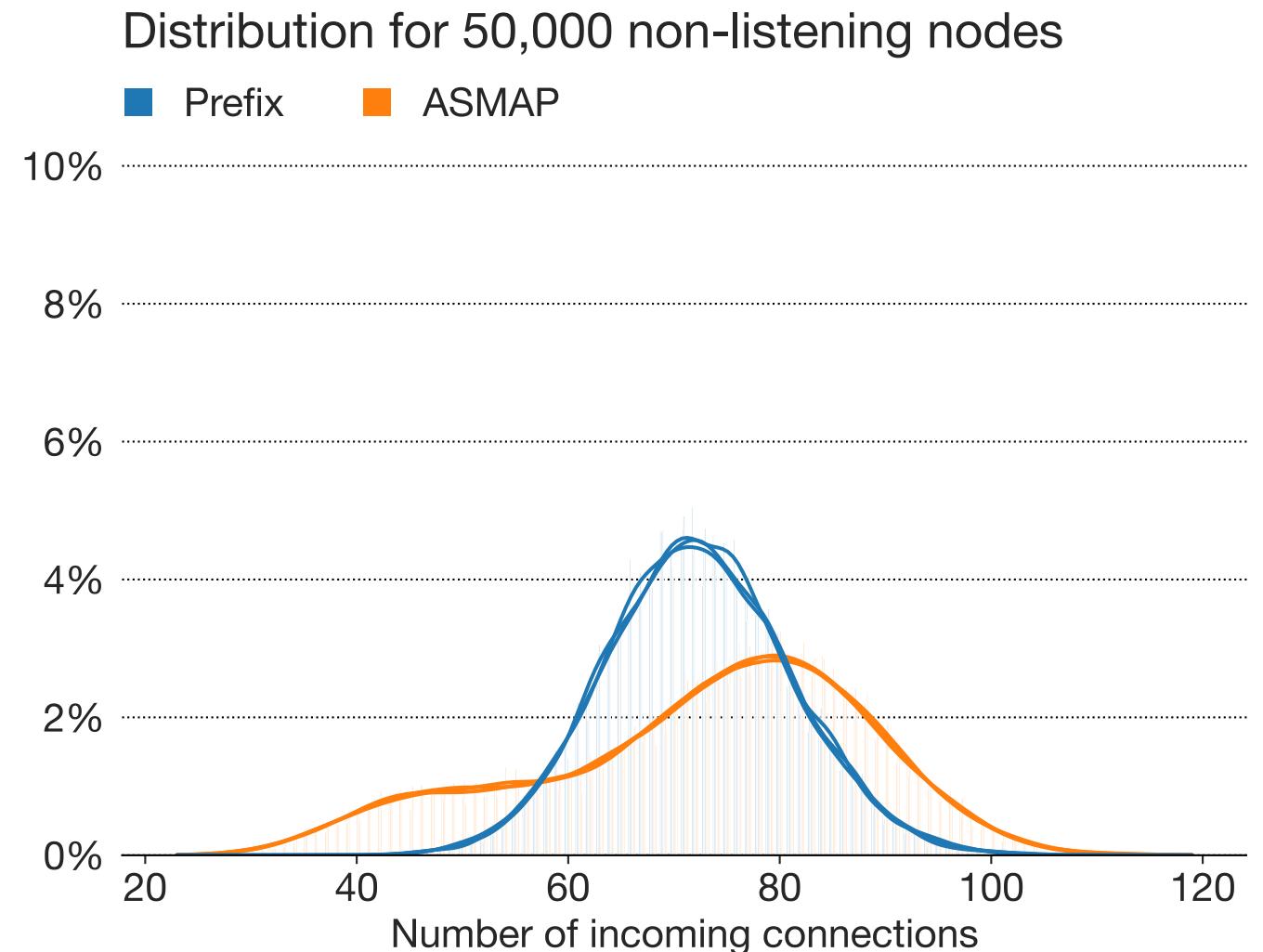
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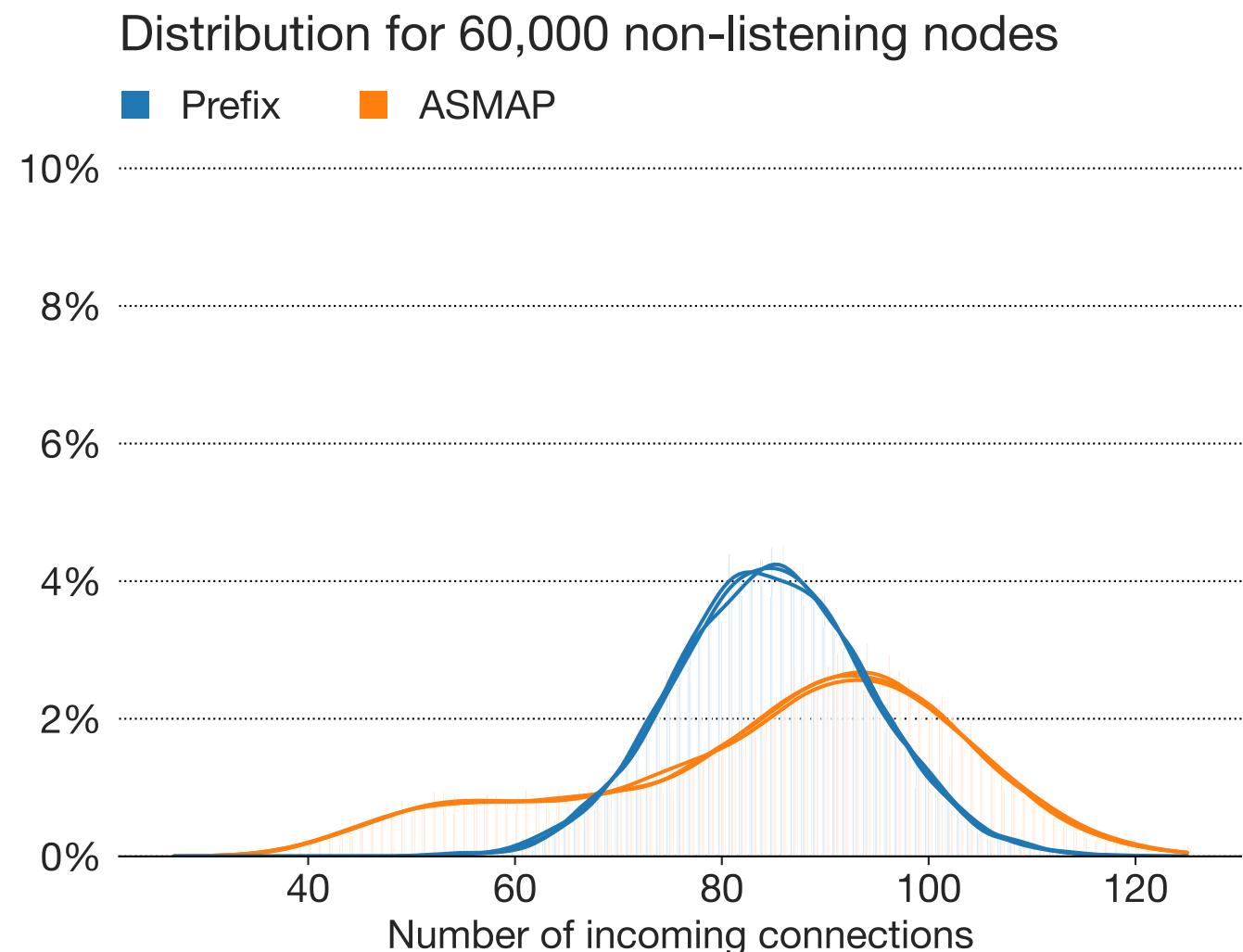
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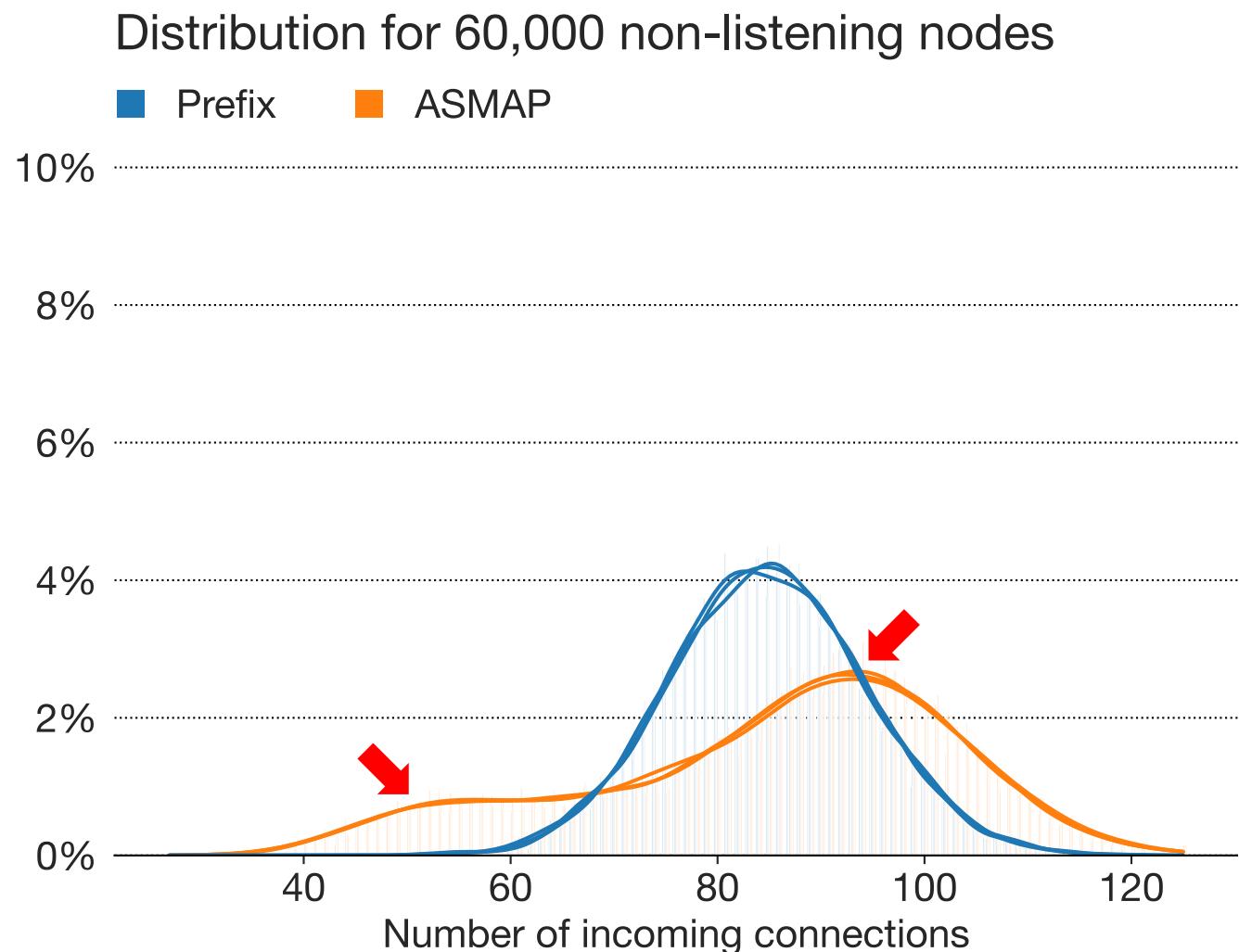


Insights 2: Autonomous systems & ASMAP: Simulation data

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- Insights

- For small n_{nl} : similar μ , larger σ
- For realistic n_{nl}
 - Separate normal distributions for "desirable" and "undesirable" nodes

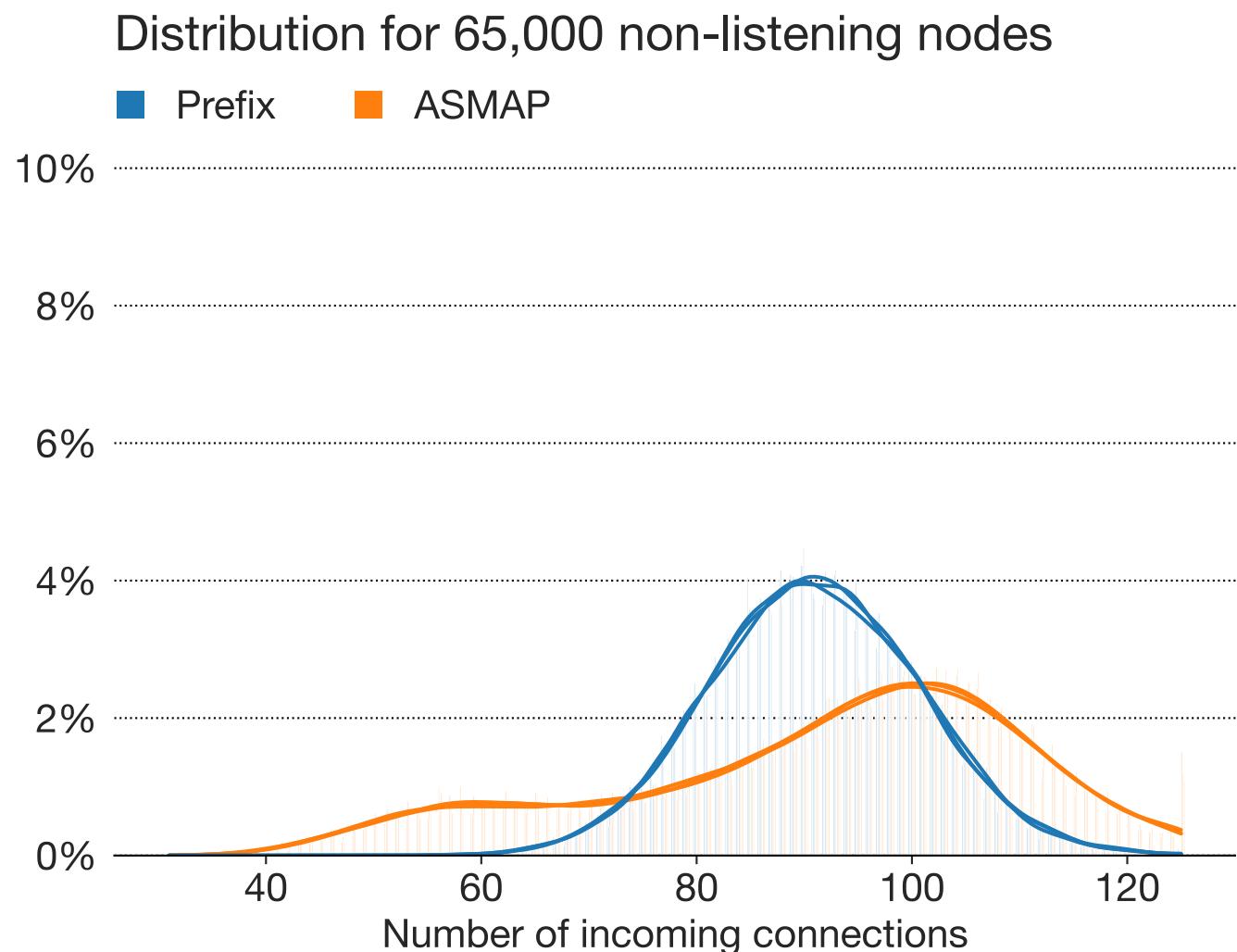


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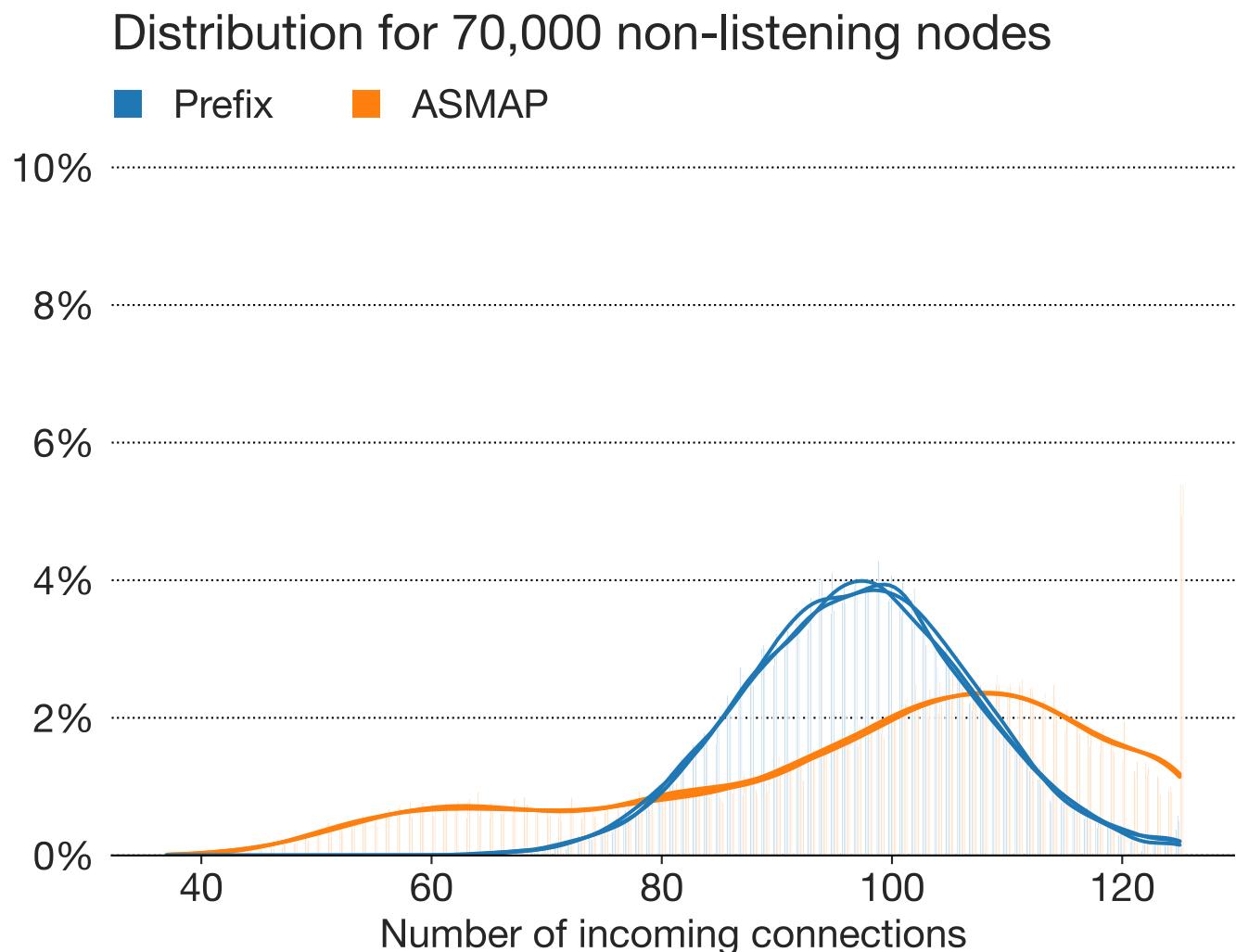


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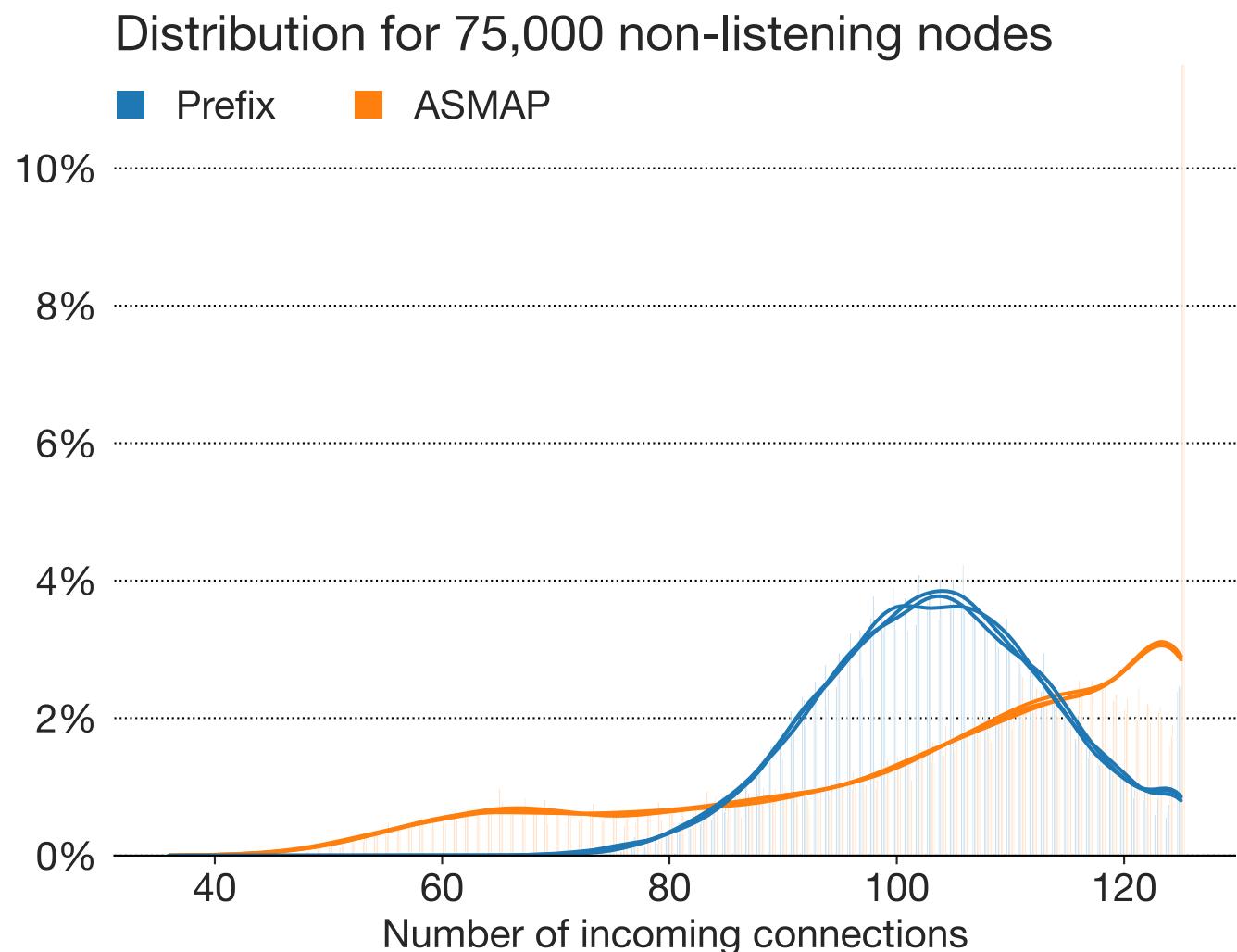


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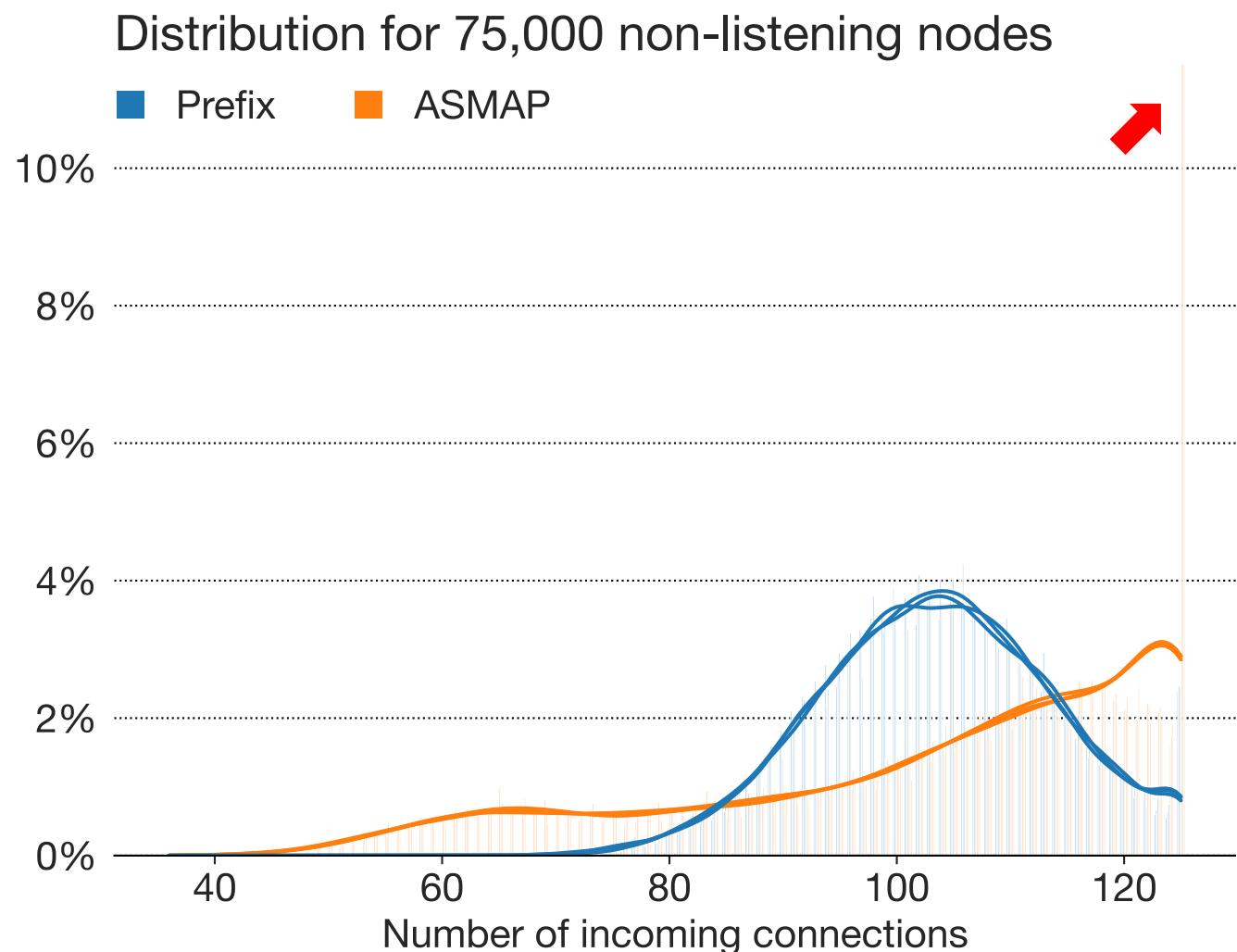


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 - Separate normal distributions for "desirable" and "undesirable" nodes
 - Higher load and connection thrashing for "desirable" nodes

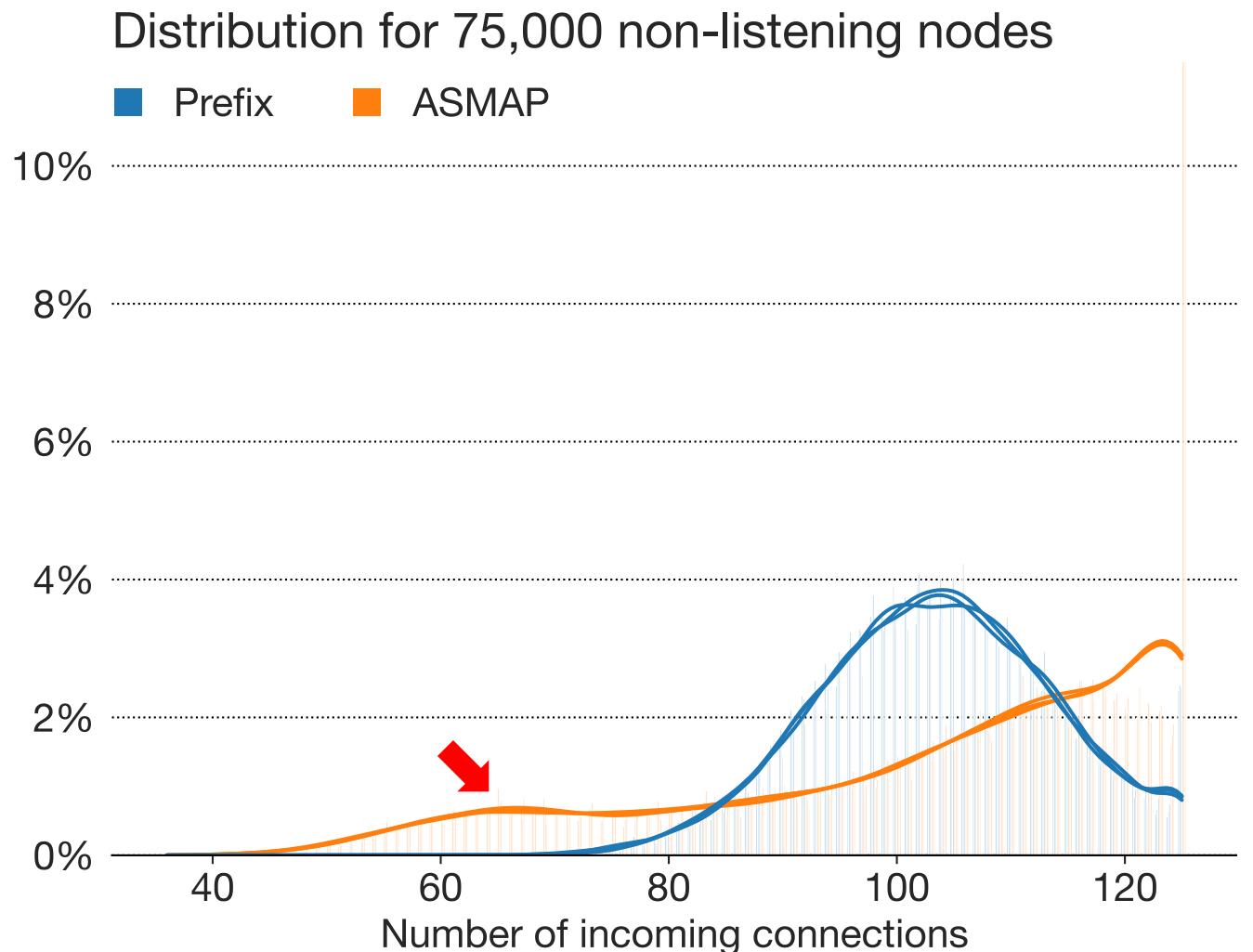


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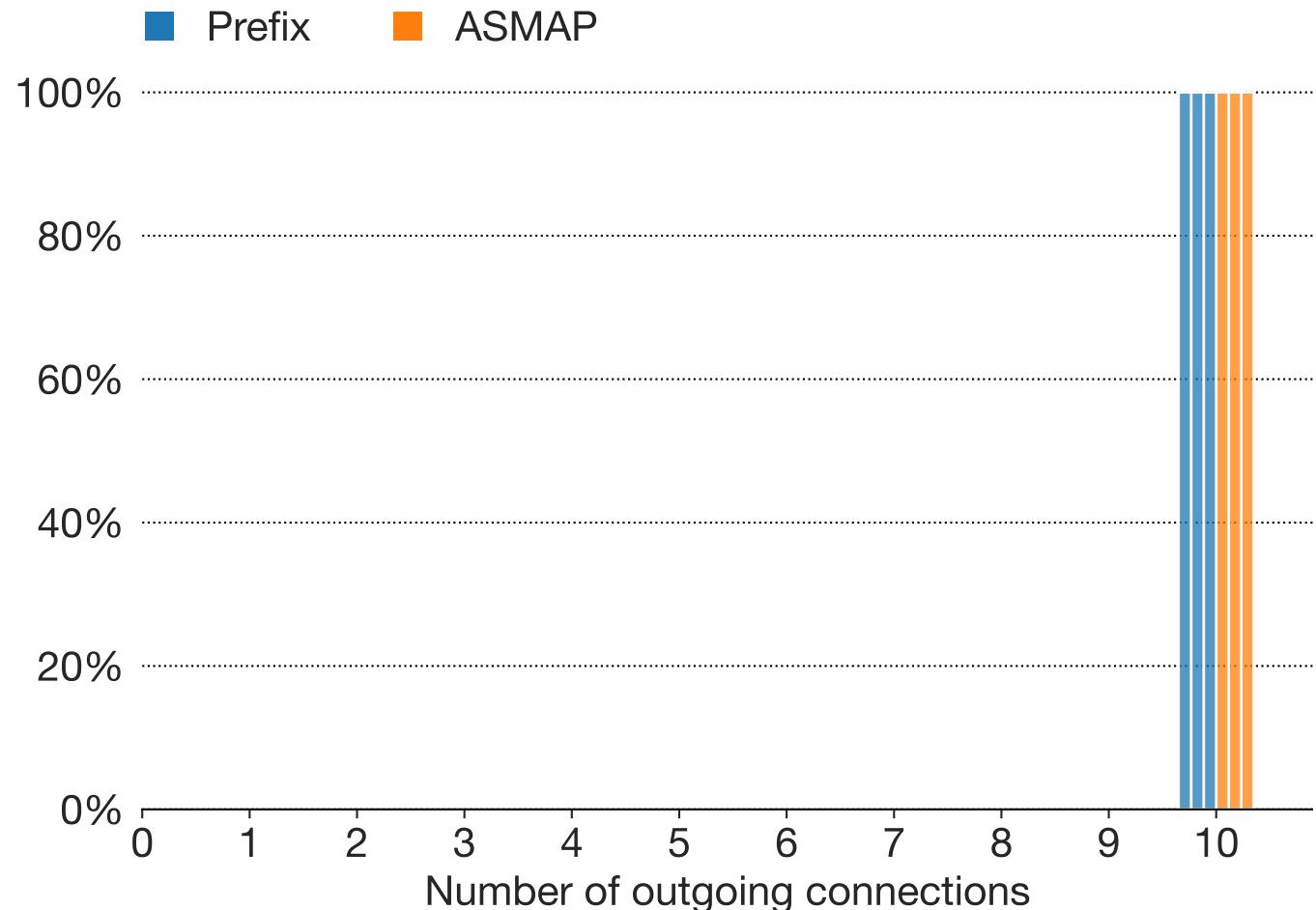
Insights 2: Autonomous systems & ASMAP: Simulation data

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Distribution for 75,000 non-listening nodes

- Insights

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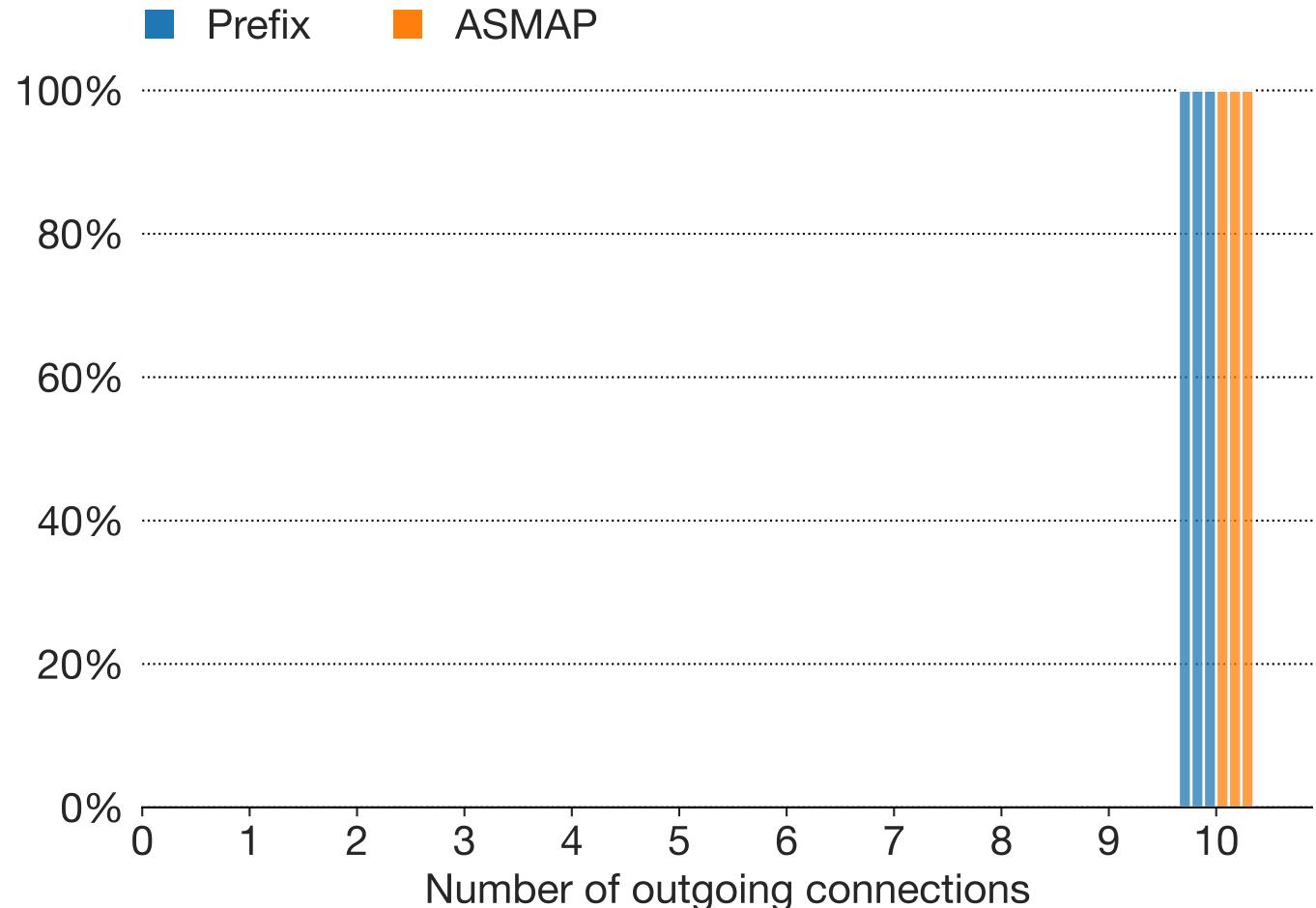
Insights 2: Autonomous systems & ASMAP: Simulation data

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Distribution for 80,000 non-listening nodes

- Insights

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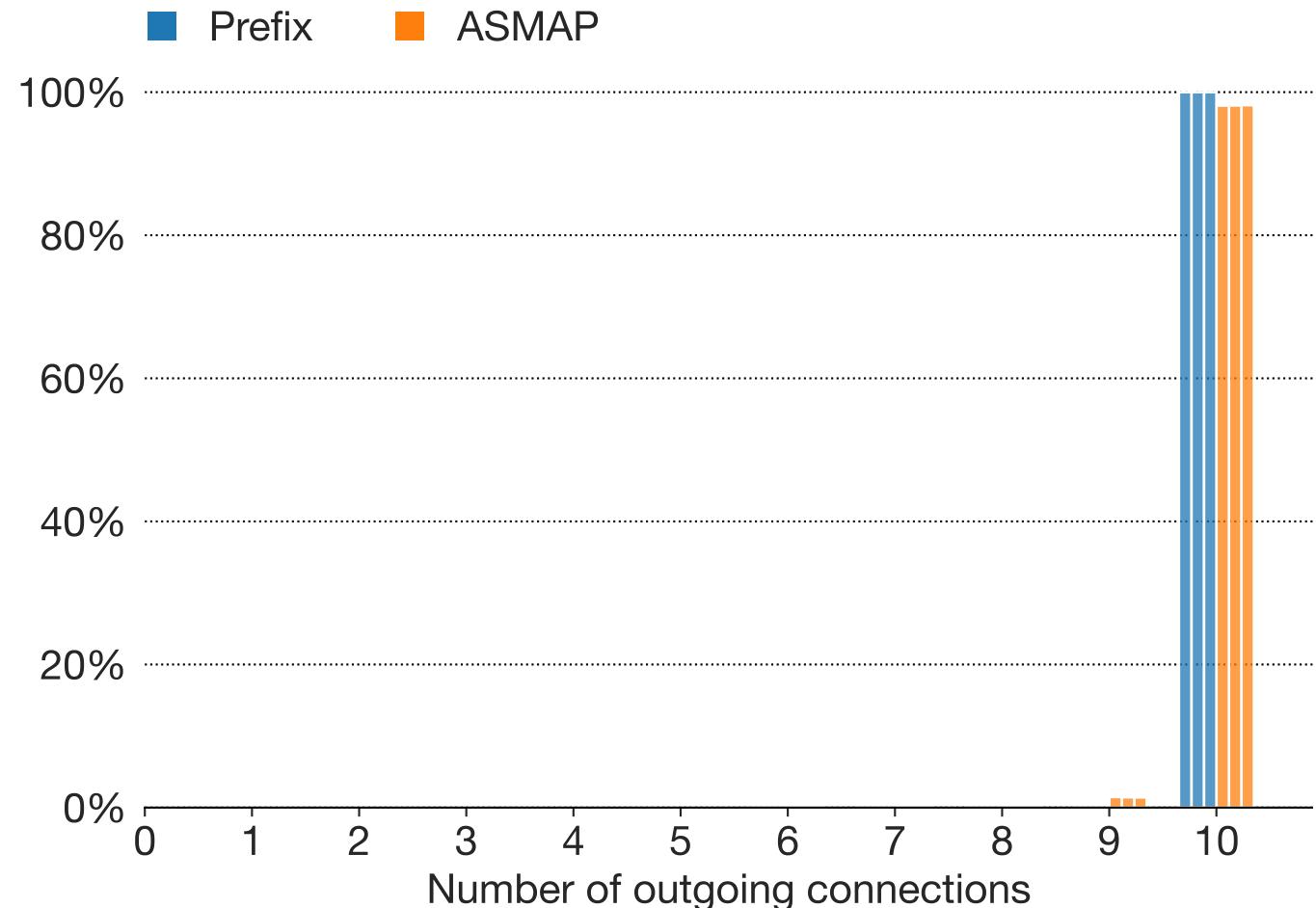
Insights 2: Autonomous systems & ASMAP: Simulation data

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Distribution for 85,000 non-listening nodes

- Insights

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 - Higher load and connection thrashing for “desirable” nodes

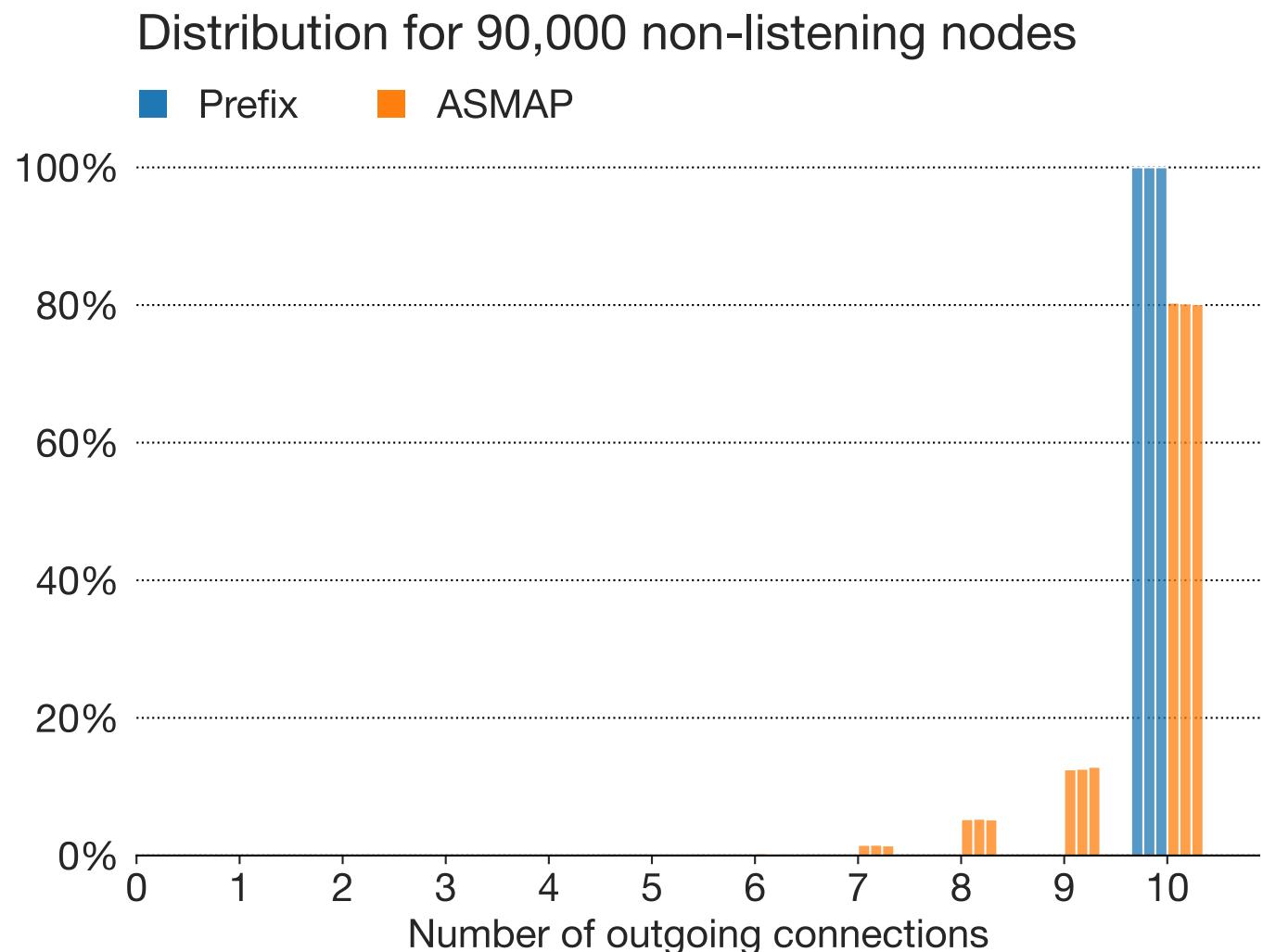


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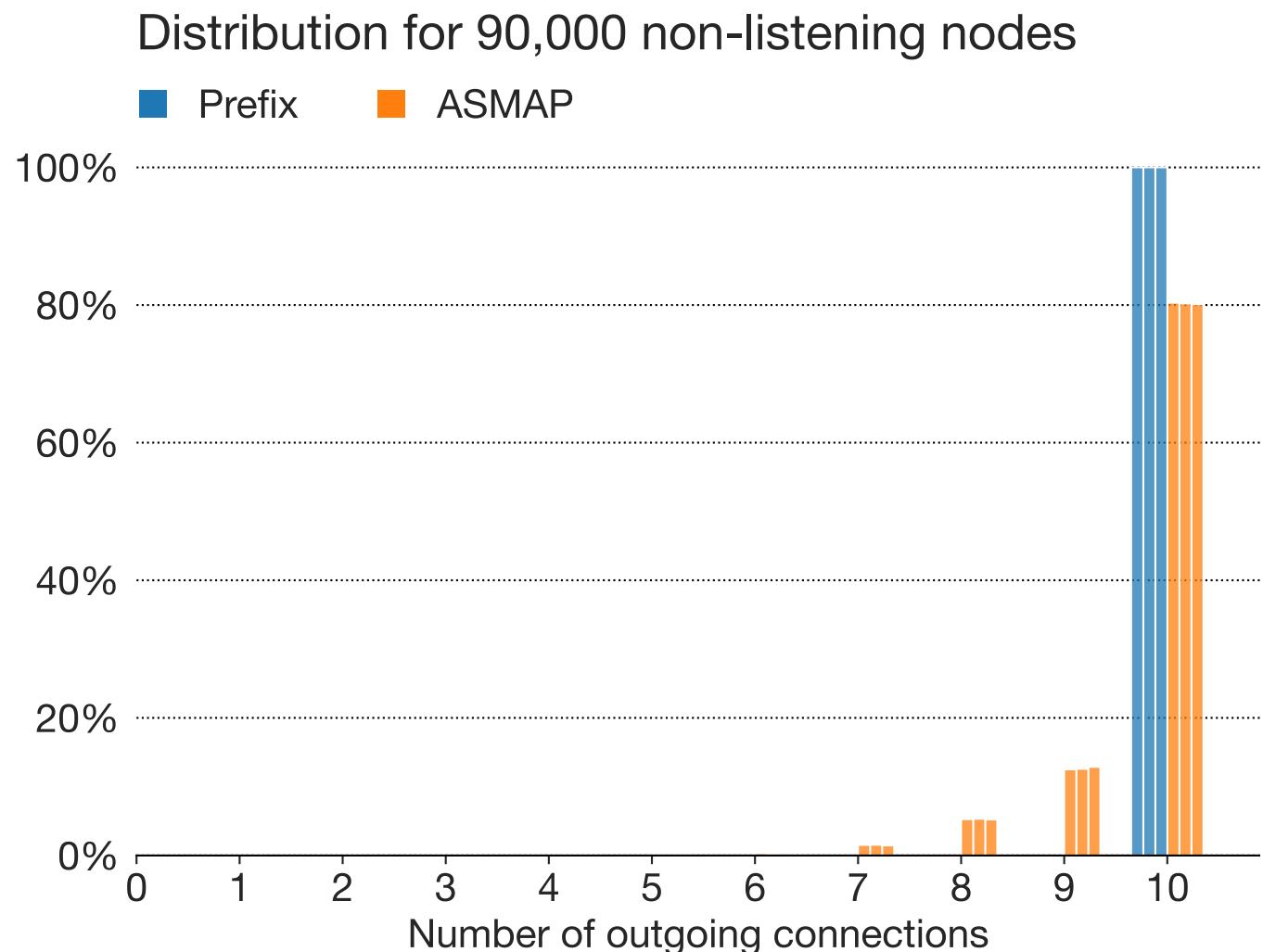


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 - Separate normal distributions for “desirable” and “undesirable” nodes
 - Higher load and connection thrashing for “desirable” nodes
 - Once “desirable” AS are saturated, remaining nodes cannot achieve ten outbound connections



Insights 2: Autonomous systems & ASMAP: Simulation data

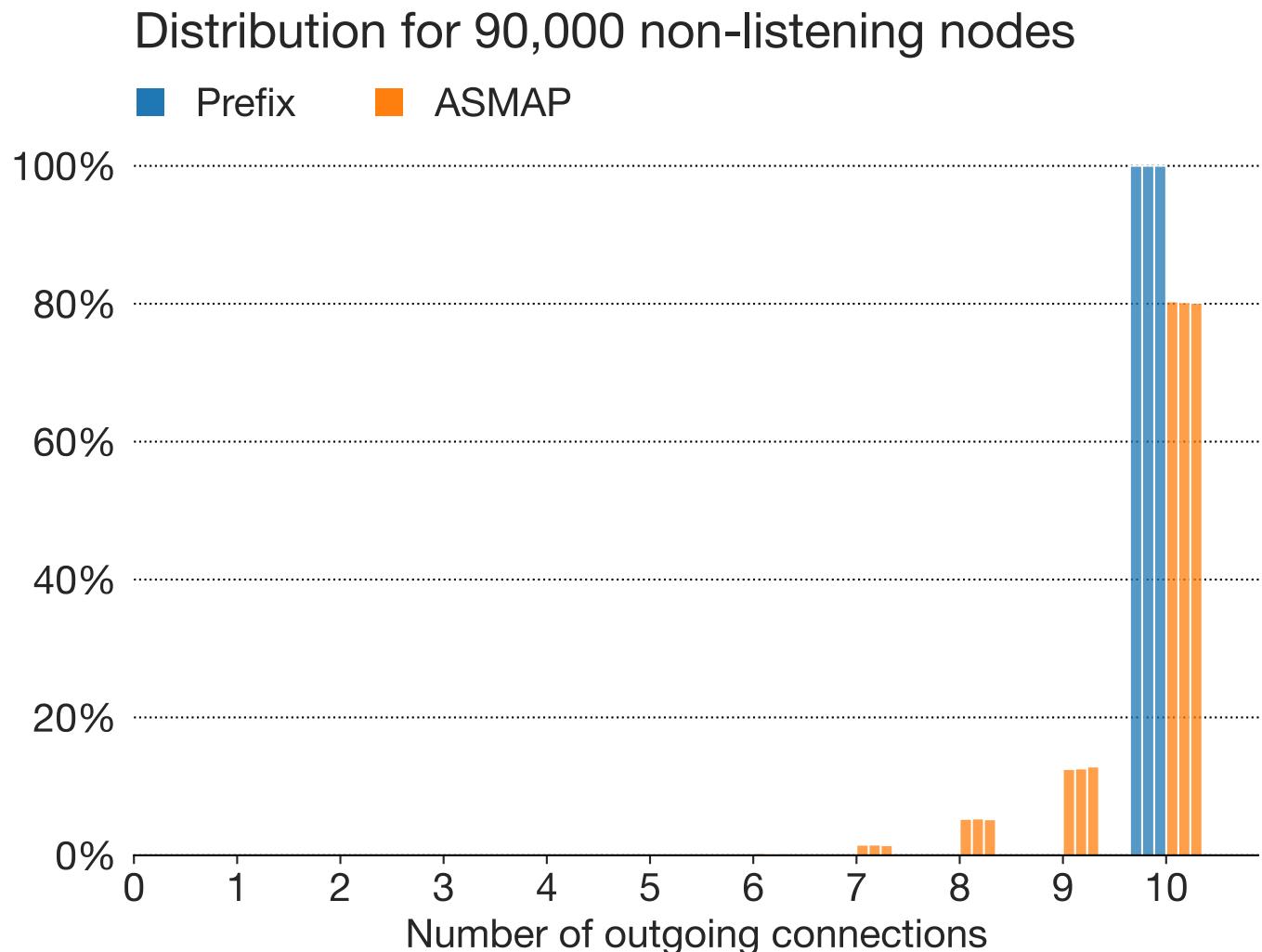
- P2P network simulator

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**CAVEAT:
SIMULATION
DATA**

Once "desirable" ASes are saturated, remaining nodes cannot achieve ten outbound connections



THANKS



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