

DHT Routing Table Health

Our DHT is in good shape!

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**The Mother of ALL DEMO DAYS
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**Protocol
Labs**

Kademlia DHT Routing Table

- ▶ A Distributed Hash Table (DHT) is a decentralized overlay network
- ▶ Each node has to know some other peers to be connected to the network, this set of peers is the node's Routing Table
- ▶ Kademlia keeps peers in k -buckets sorting the `peer_id` by XOR distance (or Common Prefix Length). Each bucket is capped at 20 peers

Example: Routing Table of peer 01101000

Bucket 0	Bucket 1	Bucket 2	Bucket 3	Bucket 4
1. 11010111	1. 00110101	1. 01011101	1. 01111011	1. 01100011
2. 10001011	2. 00001000	2. 01001111	2. 01110001	
3. 10101110	3. 00111011	3. 01010110		
4. 11110101	4. 00101101			
5. 10000010	5. 00110100			
6. 11010100				
7. 11000100				
8. ...				

Measurements data

- ▶ The Nebula Crawler crawls the IPFS network and provides all peers in the network along with their routing table for a point in time
- ▶ Data taken from 28 crawls over 1 week (4 crawls per day) starting on 2022-04-19

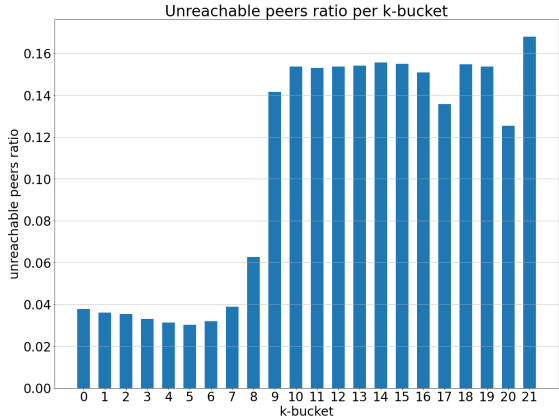
Methodology

- ▶ The Nebula Crawler provides a global snapshot of the network
- ▶ We can reconstruct the k -buckets of all peers by computing the XOR distance between a `peer_id` and the `peer_ids` of all peers in its routing table
- ▶ From the global snapshot we can find the closest peers to every other peer and verify if any peer is missing from a k -bucket
- ▶ Caveat: XOR distance is non-linear! Computationally expensive to find the closest peers to a specific `peer_id`. A python Binary Trie implementation was built for this purpose

Unreachable peers in the Routing Table

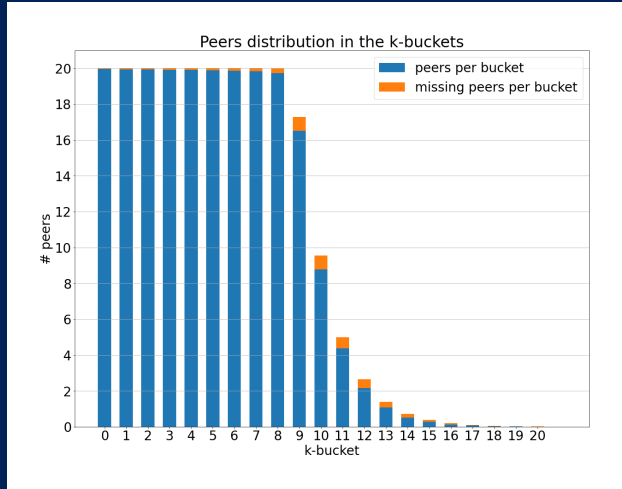
Unreachable peers may still be referenced in other peers routing tables (stale entries)

- ▶ Average for buckets 0 to 8:
3.8% ~ 0.75 peers
- ▶ Average for buckets 9 to 21:
15%



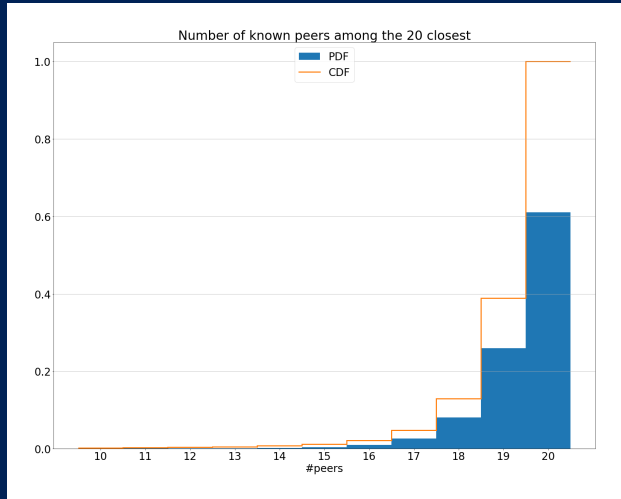
Peers distribution in the k-buckets

- ▶ Peers distribution in bucket follows an exponential growth, capped at 20
- ▶ Buckets 0–8 are missing on average 0.12 peers per bucket
- ▶ Buckets 9–14 are missing on average 0.53 peers per bucket



20 closest peers awareness

1. Probability Density Function (PDF)
 2. Cumulative Distribution Function (CDF)
- ▶ 61.1% of the peers know all their 20 closest peers
 - ▶ 95.2% of the peers know at least 18 of their 20 closest peers



Conclusion

- ▶ Very low rate of stale entries in the routing table, given high churn
- ▶ Peers distributions in the `k-buckets` as expected
- ▶ the `k-buckets` are only missing a small number of peers
- ▶ 95.2% of the nodes have at least 18 of their 20 closest peers in their Routing Table
- ▶ All results of RFM19 of are available on the `protocol/network-measurements` Github repo
- ▶ New measurements on diversity in the `k-buckets`! The DHT may become centralized over time. Make sure to attend the Measuring IPFS track at IPFS ping on Friday 2022-07-15 to learn more about it :)

References

1. RFM19 on the `protocol/network-measurements` Github repo
2. DHT Routing Table Health Notion page
3. Kademlia Paper by Petar Maymounkov and David Mazières
4. Nebula Crawler by Dennis Trautwein
5. Python Binary Trie implementation
6. ProbeLab Notion page