DHT Performance Overview

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What is a Distributed Hash Table (DHT)?

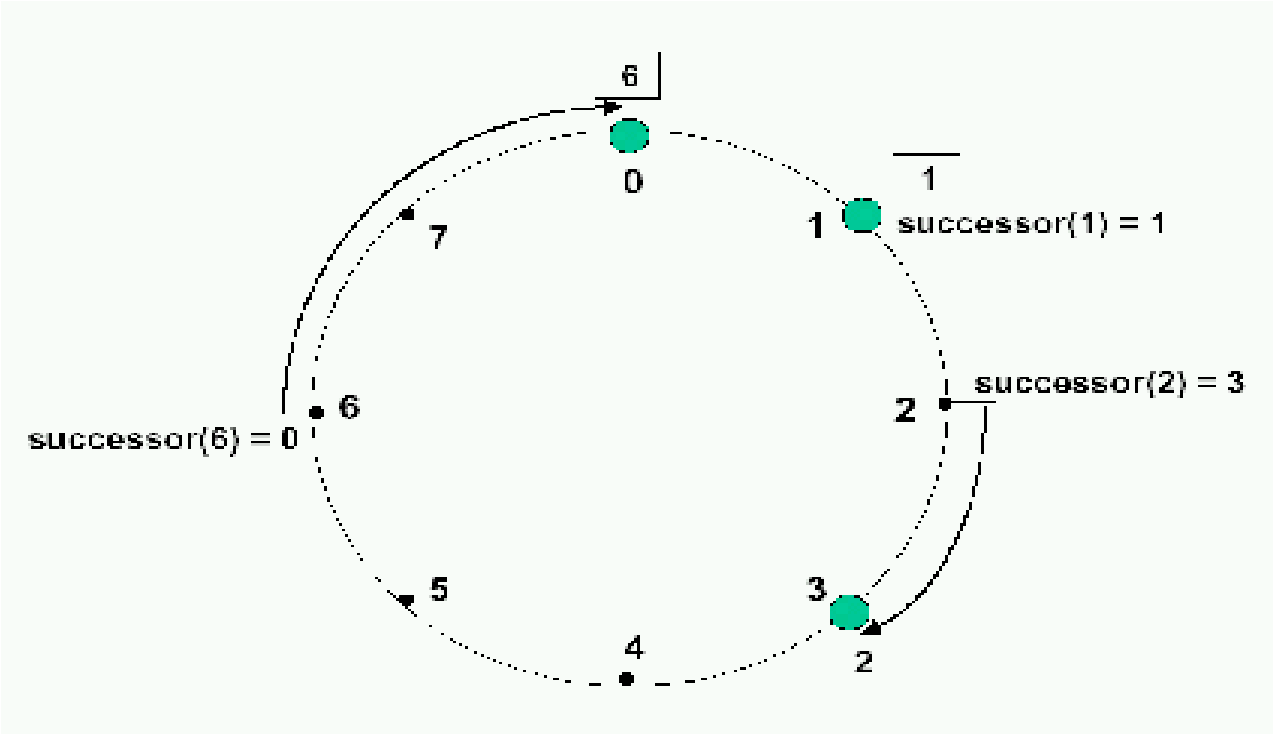
- Hash Table:
  - value = lookup(key)
  - store(key, value)
- Distributed: storage and lookups of values are distributed among multiple hosts
- Motivation: how do you find a value in a large P2P system in a scalable manner without any centralized servers or hierarchy?

Properties of DHTs

- Each node…
  - has a unique node ID
    - The value is stored at the node whose ID is closest to the key
    - Closeness = distance function
  - maintains state: a small list of the node IDs (“neighbours”) and the corresponding IP addresses
  - forwards queries for a key to the closest neighbour
- Routing geometries
  - Skiplist, tree-like, multidimensional
- Iterative vs. recursive routing (factor: 0.6)

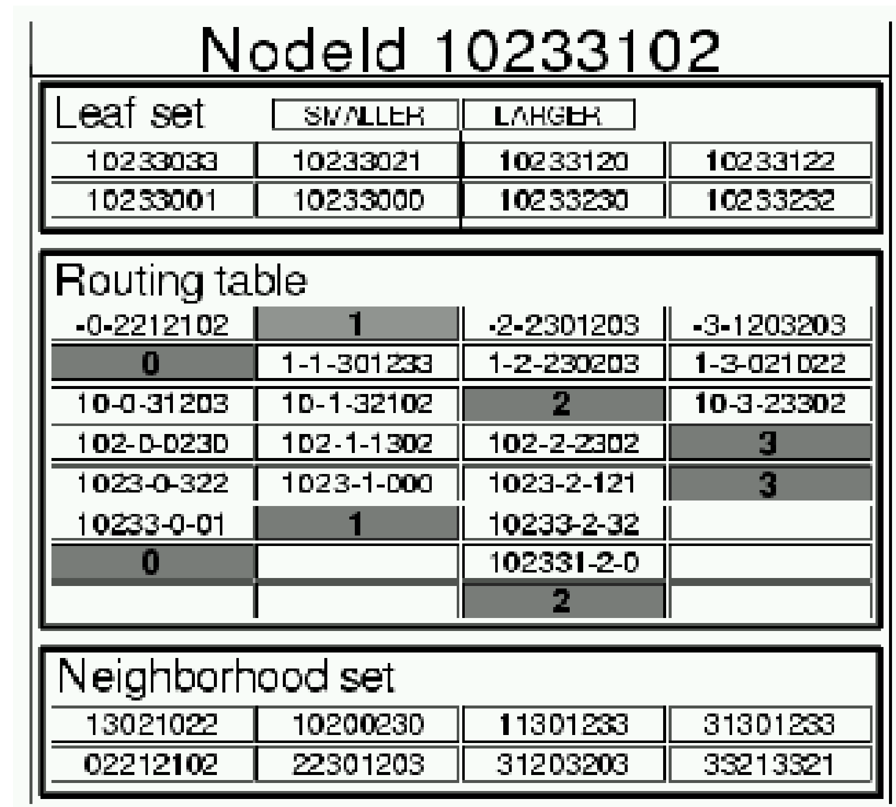
Chord (Ring)

- Distance function = numeric difference between two node Ids
- Skiplist like (power of two) routing



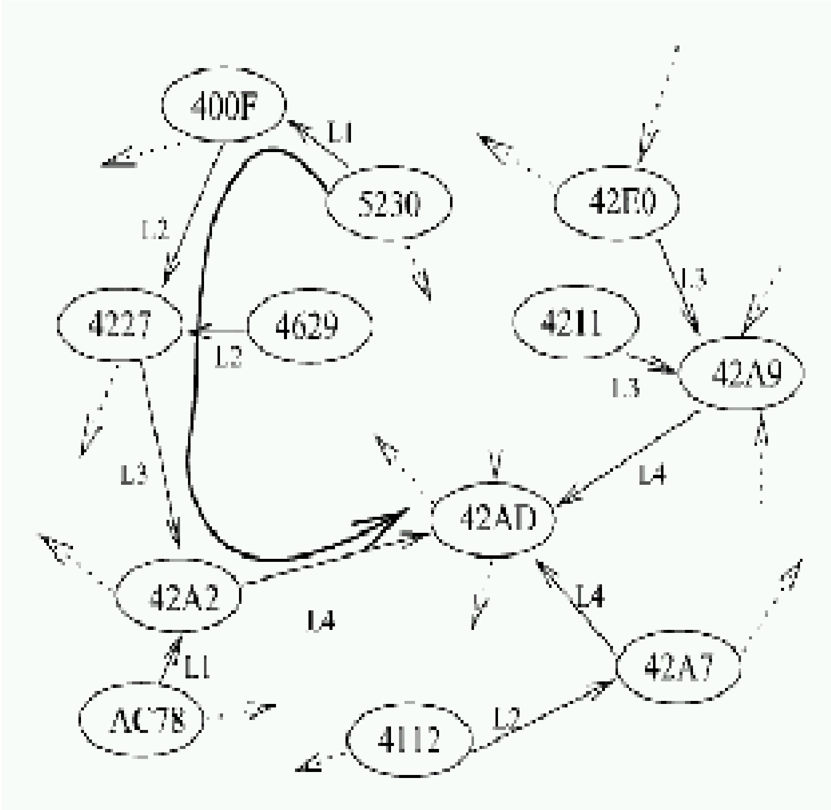
Pastry

- Distance function = number of common prefix bits
- Tree-like routing
  - Two-stage routing protocol (leaf set, routing table)



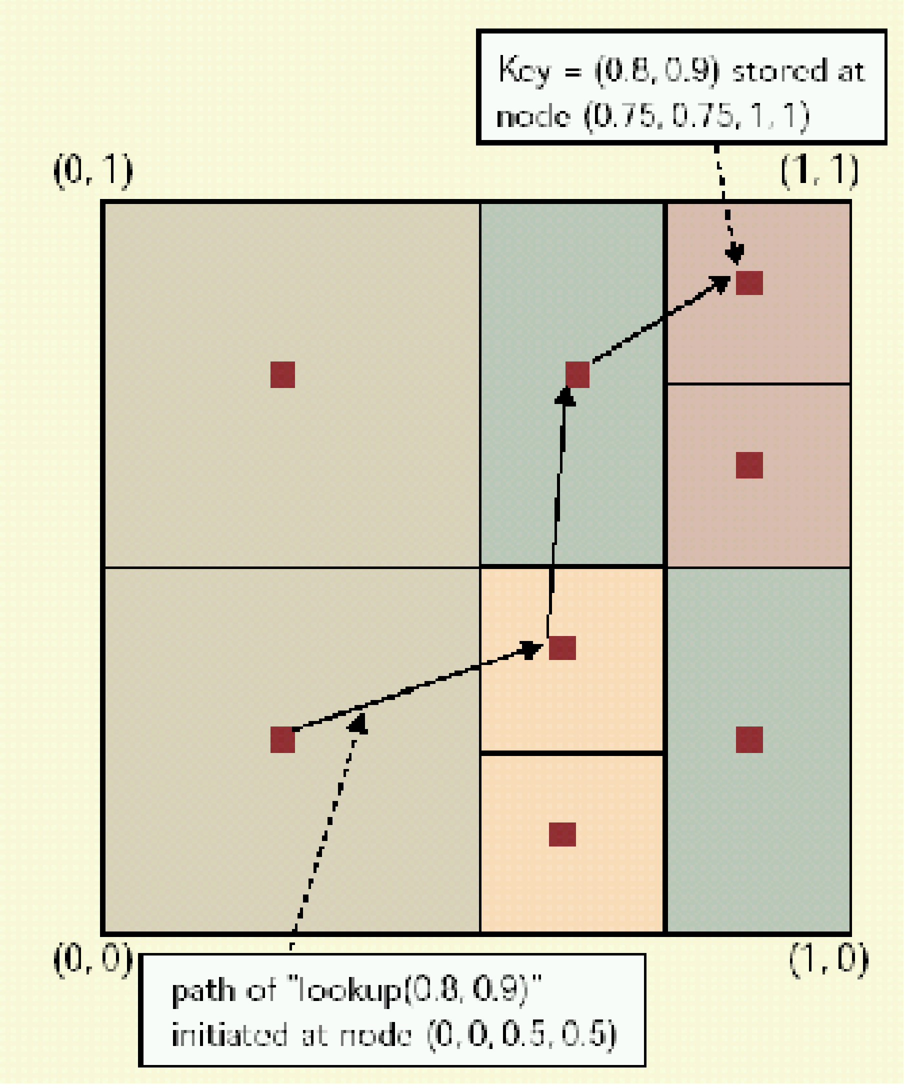
Tapestry

- Distance function = number of common prefix bits
- Tree like routing
- Uses “salt” to avoid root node failures



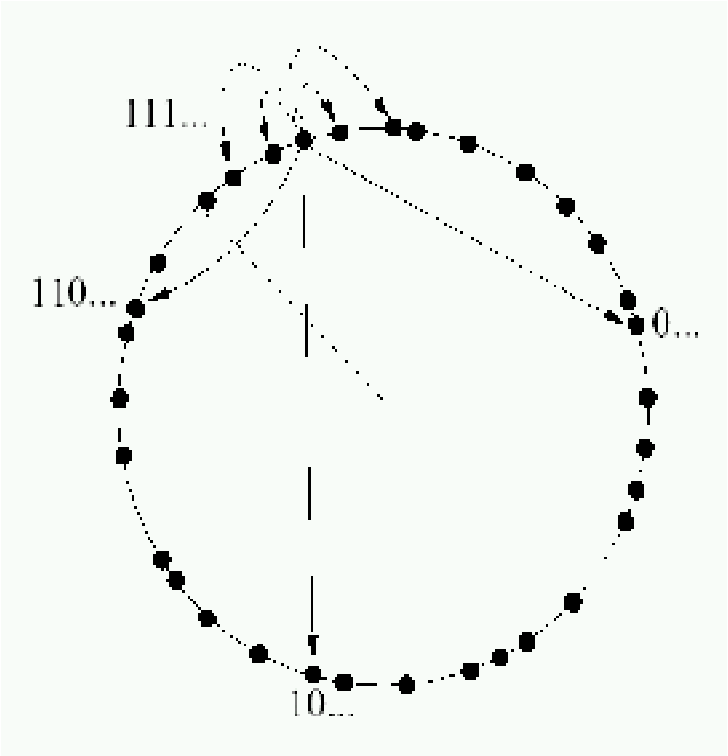
CAN

- Routing geometry: d-dimensional cartesian coordinate space
- Distance function: adjacent “zone”



Kademlia (XOR)

- Distance function = XOR (ID1,ID2)
  - Unidirectional: does not need a two-stage protocol like Pastry
  - Symmetric: no need for a stabilization protocol like in Chord; routing tables are refreshed as a side effect of ordinary lookups



Performance Evaluation

- Metrics
  - Number of hops
  - Latency
- Things that affect performance
  - Churn
  - Packet loss
  - Proximity Routing
  - Caching

Performance Bounds/Results

	Lookup	State	Relative Delay Penalty	Median HOP count
Chord	O(logN)	O(logN)	6	7
Pastry	O(logN)	O(logN)	9	8
Tapestry	O(logN)	O(logN)	N/A	8
CAN	$O(dN^{1/d})$	O(d)	6	8
Kamdelia	O(logN)	O(logN)	N/A	8

RDP = 1000 nodes, no failures
HOP = 65536 nodes, no failures

Optimal Lookup and State

- Beehive achieves O(1) performance with proactive caching
- Butterfly keeps only O(1) state
  - Caveat: Median hop count 21

Resiliance and Recovery

- Resiliance through flexibility
  - Flexibility in neighbour selection yields better paths than route selection
  - Chord and Kamdelia have the greatest flexibility
  - Tree and butterfly have the least
- Churn recovery
  - Periodic better than reactive

Summary

- Performance of all DHT algorithms is pretty good
- DHTs can handle churn (P2P enviroments) and path failovers
- O(1) lookups with proactive caching (DNS?)
- Lot's of papers and implementations available

Future Work

- Authentication, Authorization, Accounting
  - The impact on performance
- So far, only application level – would this work directly on network level?
- Competing free version of i3?

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