

- For each peer
 - successor link on the ring
 - predecessor link on the ring
 - for all $i \in \{0,..,m\text{-}1\}$
 - Finger[i] := the peer following the value r_V(b+2ⁱ)
- For small i the finger entries are the same
 - store only different entries
- Chord
 - needs O(log n) hops for lookup where.
 - needs O(log² n) messages for inserting and erasing of peers w.h.p.



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Routing-Techniques for CHORD: DHash ++

- Frank Dabek, Jinyang Li, Emil Sit, James Robertson, M. Frans Kaashoek, Robert Morris (MIT) "Designing a DHT for low latency and high throughput", 2003
- Idea
 - Take CHORD
- Improve Routing using
 - 4 Data layout
 - Recursion (instead of Iteration)
 - Next Neighbor-Election
 - Replication versus Coding of Data
 - Error correcting optimized lookup
- Modify transport protocol





- Distribute Data?
- Alternatives
 - Key location service
 - store only reference information
 - Distributed data storage
 - distribute files on peers
 - Distributed block-wise storage
 - either caching of data blacks

PAST, PASTRY

or block-wise storage of all data over the network







A Recursive Versus Iterative Lookup

- Iterative lookup
 - Lookup peer performs search on his own
- Recursive lookup
 - Every peer forwards the lookup request
 - The target peer answers the lookupinitiator directly
- DHash++ choses recursive lookup
 - speedup by factor of 2





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A Recursive Versus Iterative Lookup

DHash++ choses recursive lookup



- speedup by factor of 2





- RTT: Round Trip Time
 - time to send a message and receive the acknowledgment
- Method of Gummadi, Gummadi, Grippe, Ratnasamy, Shenker, Stoica, 2003, "The impact of DHT routing geometry on resilience and proximity"
 - Proximity Neighbor Selection (PNS)
 - Optimize routing table (finger set) with respect to (RTT)
 - method of choice for DHASH++
 - Proximity Route Selection(PRS)
 - Do not optimize routing table choose nearest neighbor from routing table



9













- Gummadi, Gummadi, Grippe, Ratnasamy, Shenker, Stoica, 2003, "The impact of DHT routing geometry on resilience and proximity"
 - Proximity Neighbor Selection (PNS)
 - Optimize routing table (finger set) with respect to (RTT)
 - method of choice for DHASH++
 - Proximity Route Selection(PRS)
 - Do not optimize routing table choose nearest neighbor from routing table
- Simulation of PNS, PRS, and both
 - PNS as good as PNS+PRS
 - PNS outperforms PRS







Next Neighbor Selection

- DHash++ uses (only)
 PNS
 - Proximity Neighbor Selection
- It does not search the whole interval for the best candidate
 - DHash++ chooses the best of 16 random samples (PNS-Sample)





- DHash++ uses (only) PNS
 - Proximity Neighbor Selection
- e (0.1,0.5,0.9)-percentile of such a PNS-





A Cumulative Performance Win









- Combines a large quantity of techniques
 - for reducing the latecy of routing
 - for improving the reliability of data access
- Topics
 - latency optimized routing tables
 - redundant data encoding
 - improved lookup
 - transport layer
 - integration of components
- All these components can be applied to other networks
 - some of them were used before in others
 - e.g. data encoding in Oceanstore
- DHash++ is an example of one of the most advanced peerto-peer networks