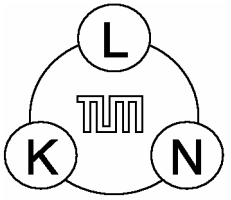

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Hybrid DHT Design for Mobile Communications Environments

Dagstuhl-Seminar "Peer-to-Peer Systems and Applications“
2006-03-29

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in cooperation with:

P2P Networking in Mobile Scenarios

Special challenges:

- Mobility of users (covered by lower OSI-layers)
- High costs of mobile data transfer
  → High churn rates
- Limited resources of mobile devices
- Low transmission data rates
- High failure probability
  (link breaks, discharged batteries)

DHTs in Mobile Scenarios

Disadvantages resulting from:

- High churn rates
  → high maintenance traffic
- High node failure probability
  → unavailability of shared content

Hybrid DHT Design

Two classes of nodes:

Static nodes

- highly-available
- long session length
- large resources
- store all object references

Temporary nodes

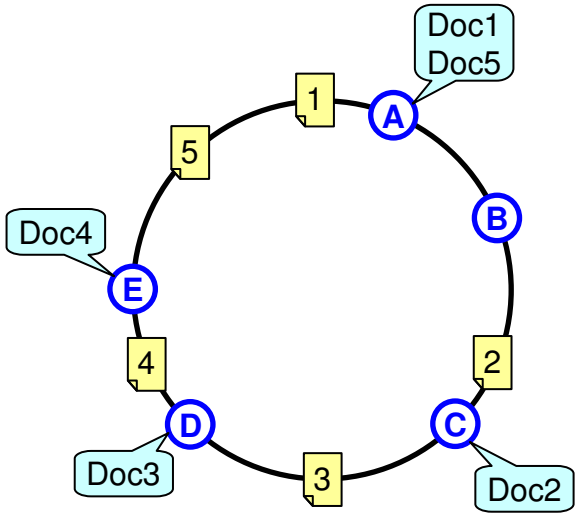
- join overlay network usually for a short period of time
- do not store object references
- forward all incoming requests to closest static node

Object references are stored only at static nodes!

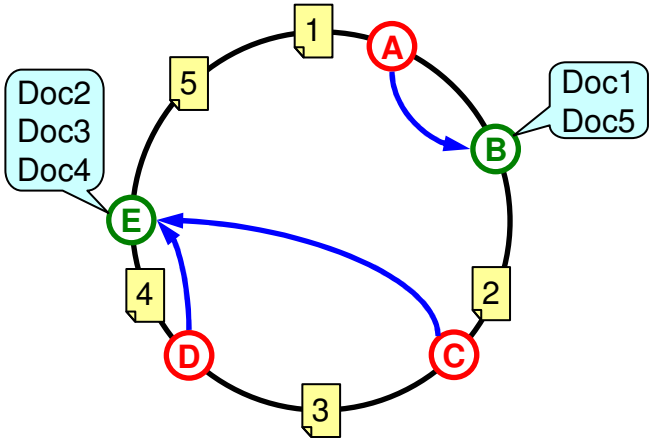
→ Significantly reduced network maintenance traffic
→ Decreased load and traffic for temporary (mobile) nodes
→ Increased availability of content

Chord and Hybrid Chord Protocol

Chord Protocol:

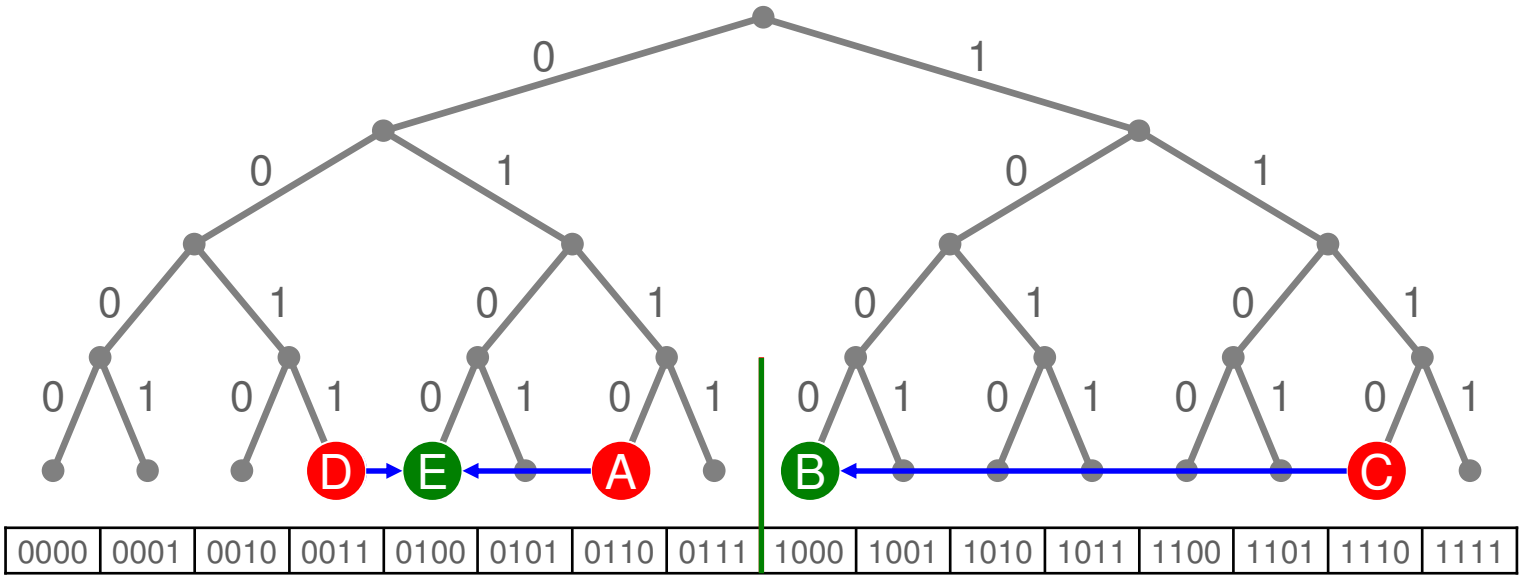


Hybrid Chord Protocol:



Static nodes: B, E
Temporary nodes: A, C, D

Kademlia and Hybrid Kademlia Protocol



- A H(A) = 0110
- B H(B) = 1000
- C H(C) = 1110
- D H(D) = 0011
- E H(E) = 0100

From Kademlia to Hybrid Kademlia:

Static nodes: B, E
Temporary nodes: A, C, D

Realization

Different JOIN and LEAVE procedures:

```
n.joinStatic()
  setupRoutingTable();
  n = find_next_static(n.id);
  transfer_matching_references(n);
  start_timers();

n.joinTemporary()
  setupRoutingTable();
  n = find_next_static(n.id);
  set_next_static(n);
  start_timers();

n.leaveStatic()
  n = find_next_static(n.id);
  transfer_references(n);
  inform_neighboring_nodes();
  stop_timers();

n.leaveTemporary()
  inform_neighboring_nodes();
  stop_timers();
```

Pseudocode for hybrid system structure setup

Simulation setup

- Chord and Hybrid Chord Protocol
- Modified NS-2 implementation (only overlay sim.)
- Traffic generator allows definition of different node classes (with appropriate parameters)

```
nodeclass WLAN_NOTEBOOK
    mean_online_time 3600s
    failure_probability 10%
    shared_objects 50
    query_rate 300s
nodeclass UMTS_PHONE
    mean_online_time 1800s
    failure_probability 25%
    shared_objects 20
    query_rate 120s
nodeclass GPRS_PHONE
    mean_online_time 900s
    failure_probability 50%
    shared_objects 5
    query_rate 60s
initial
    100 WLAN_NOTEBOOK
    100 UMTS_PHONE
    100 GPRS_PHONE
simulation-duration 1h
```

Evaluation of Maintenance Traffic

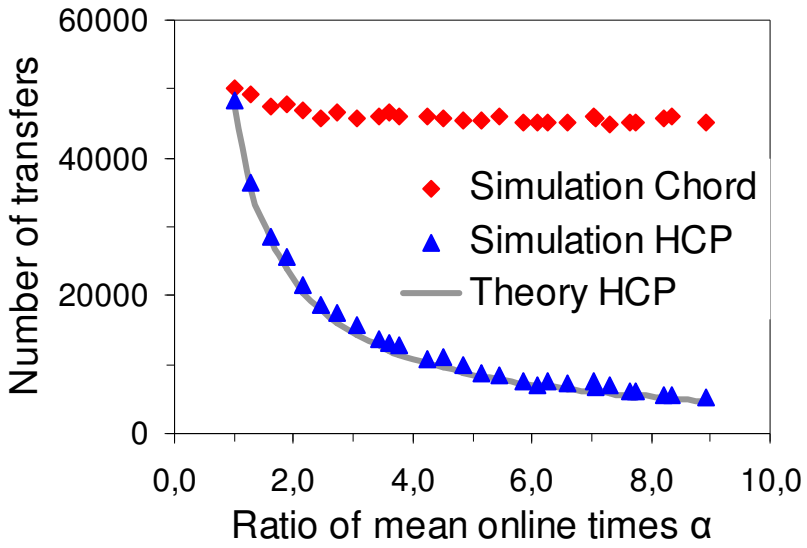
Analytical evaluation[1]:

- Traffic generated by shifting object references: λ
- Average session length of a Chord node: T_{Chord}
- Average session length of a static HCP node: $T_{HCP,static}$

$$\lambda_{HCP} = \frac{1}{\alpha} \cdot \lambda_{Chord} \quad with \quad \alpha = \frac{T_{HCP,static}}{T_{Chord}}$$

Simulation:

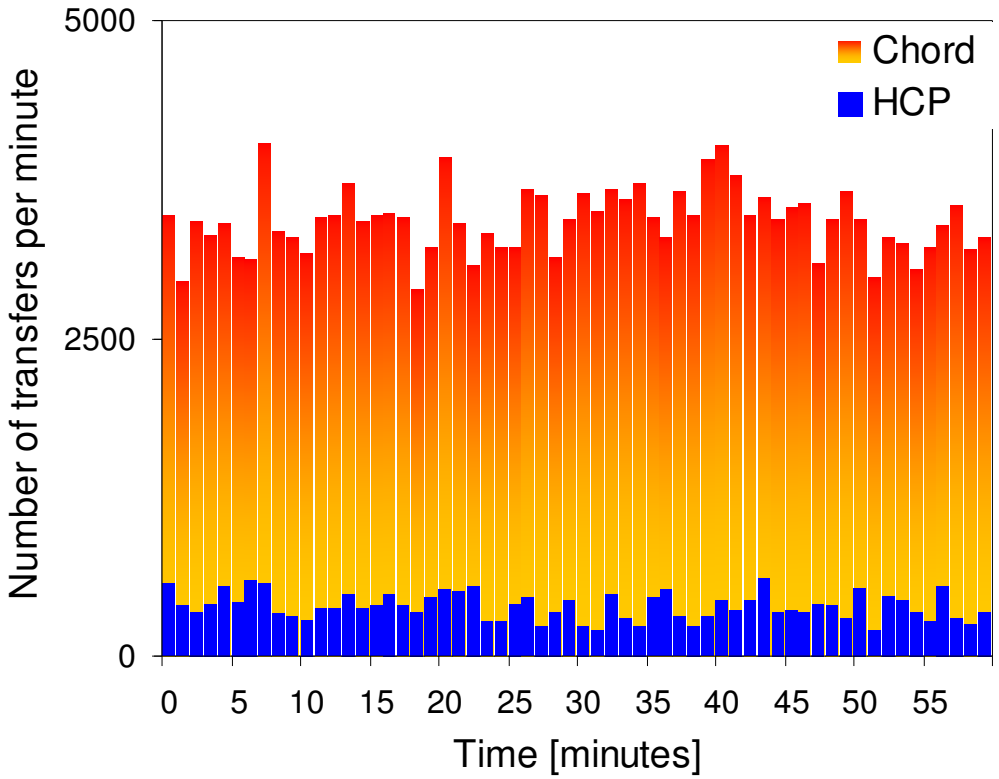
- 1000 nodes
- 100 static, 900 temporary
- Mean session length:
  - static nodes: 300s…3000s
  - temporary nodes: 300s



[1] S. Zöls, S. Schubert, W. Kellerer, Z. Despotovic, „Hybrid DHT Design for Mobile Environments“, AP2PC 2006.

Real World Scenario – Maintenance Traffic

- 2000 nodes, partitioned into five different node classes:
  - 100 office computers
  - 700 DSL subscribers
  - 400 ISDN users
  - 400 PDAs
  - 400 mobile phones
- Hybrid Chord Protocol selects office and DSL nodes as static nodes

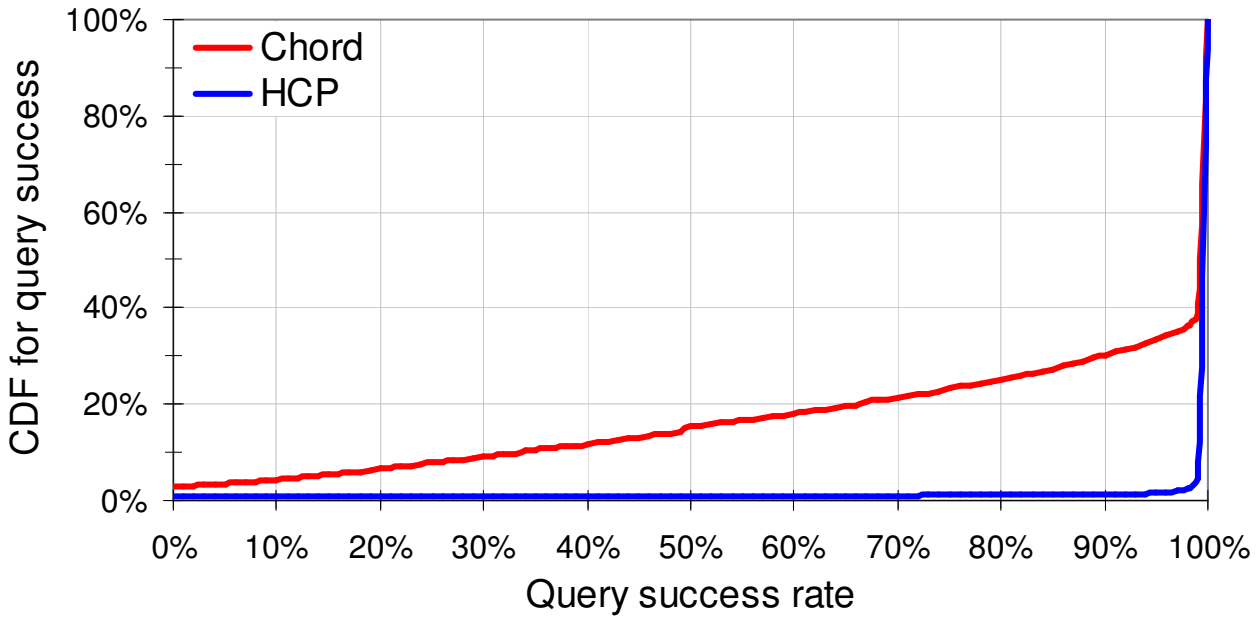


Real World Scenario – Query Success

- Definition:

$$\text{Query success rate} = \frac{\text{Number of hosts in query result}}{\text{Number of providing hosts}}$$

- Republishing of shared objects every 900s



Summary

- Goal: Extension of DHTs to mobile environments
- Hybrid DHT Design:
  - Static nodes
  - Temporary nodes
- Advantages:
  - ✓ Easy to implement
  - ✓ Disburdening of mobile participants
  - ✓ Significantly decreased maintenance traffic
  - ✓ Increased content availability