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Optimally Efficient Multicast in Structured Peer-to-Peer Networks

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Agenda

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- **Introduction**
- **DTC Construction**
- **Evaluation**
- **Outlook**

Introduction

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Multicast is performed by a distributed tree construction (DTC) algorithm

- **Tree uses only local information**
- **No peer receives any message twice**
- **Tree depth comparable to related multicast approaches**

Many application domains:

- **Streaming**
- **Prefix search**
- **Range queries**
- **Location based services**

Agenda

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Introduction

DTC Construction

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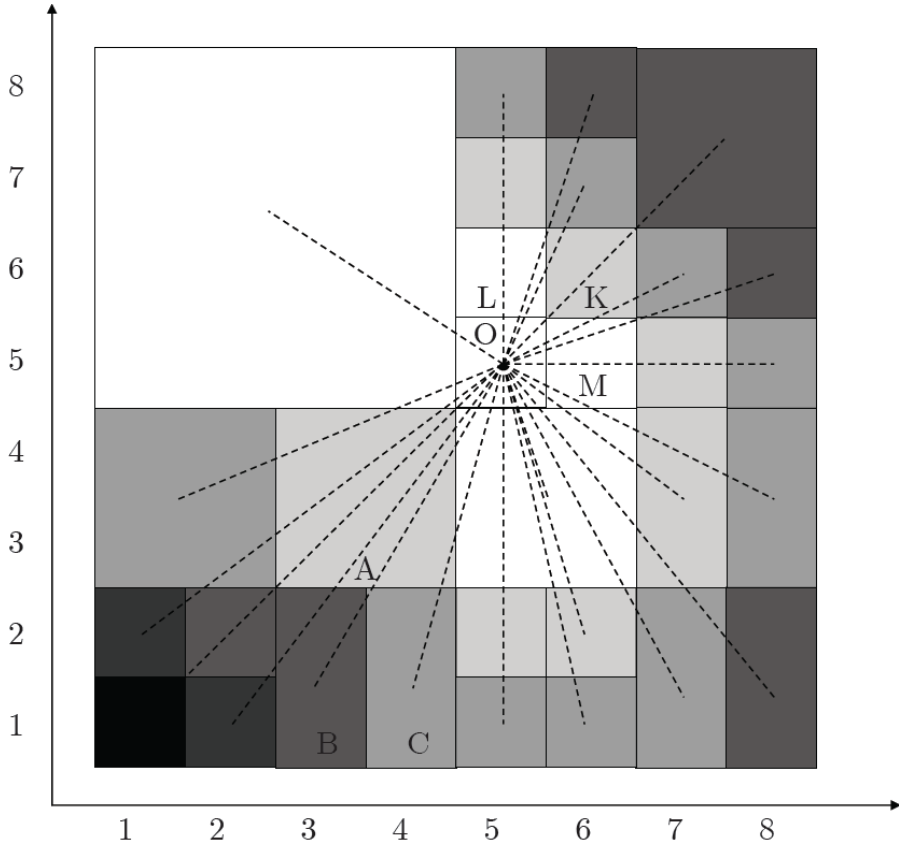
DTC In Content Addressable Network



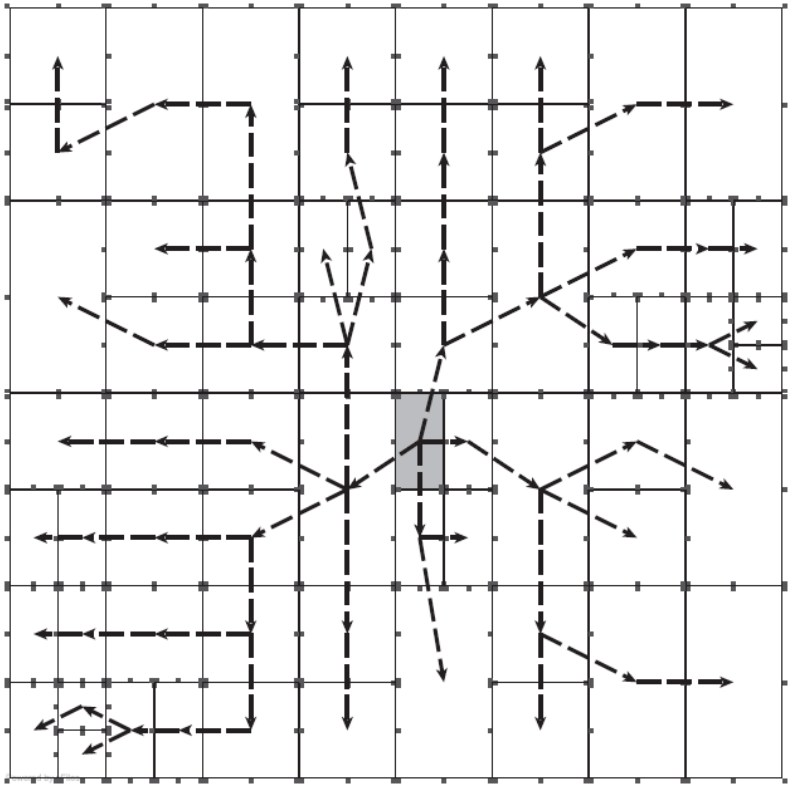
Origin O starts DTC and sends its own position with the multicast message.

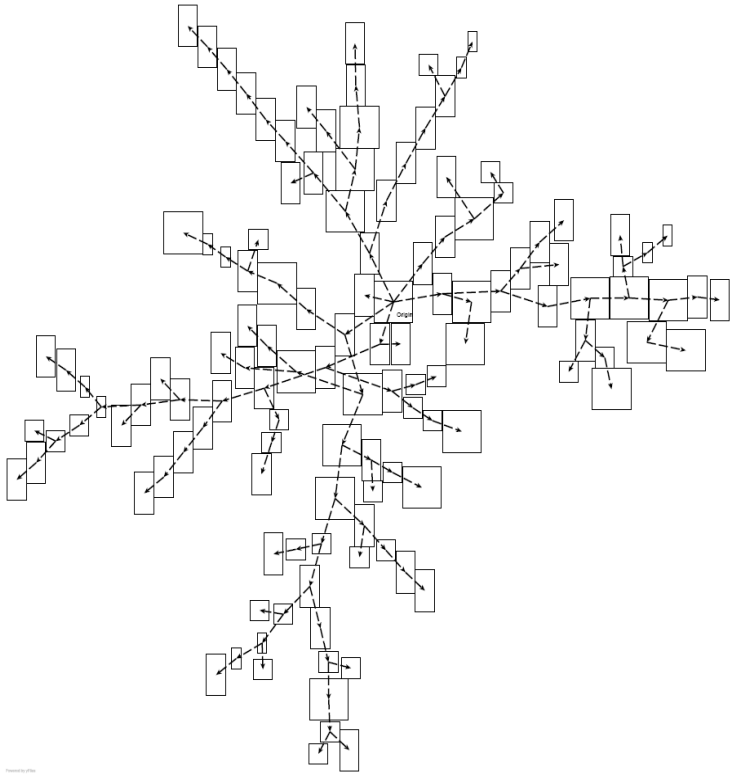
DTC Construction Rule

When a peer X receives the query,
it computes for every one of its neighbors the vector from the center of the root's zone to the center of the neighbor's zone.
If that vector intersects the common border surface between X and the neighbor, then X should add that neighbor as its child.

Assumption: Size of neighbor's zone is known locally

DTC Tree





Subset of CAN overlay. Multicast is started from marked node and forms a tree.

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Average number of messages received per node

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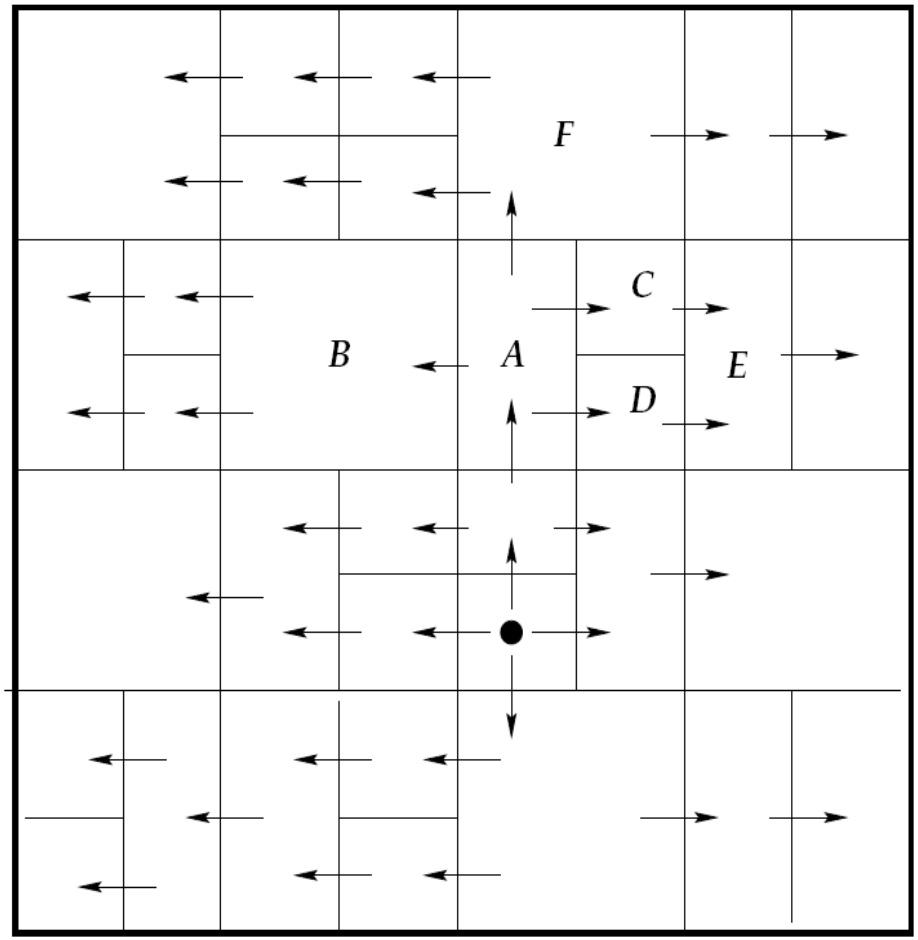
Messages Received	DTC CAN	Simple Flooding	ALM
1	2000	1	1224
2-3	0	2	684
4-5	0	6	78
6-7	0	22	12
8-9	0	67	2
10-11	0	247	0
12-13	0	925	0
>14	0	Sum 7851	0
Sum	**2000**	**26106**	**3168**

CAN network:

- 2000 nodes
- 10 dimensions
- Averaged over 30 simulations

ALM In Content Addressable Network



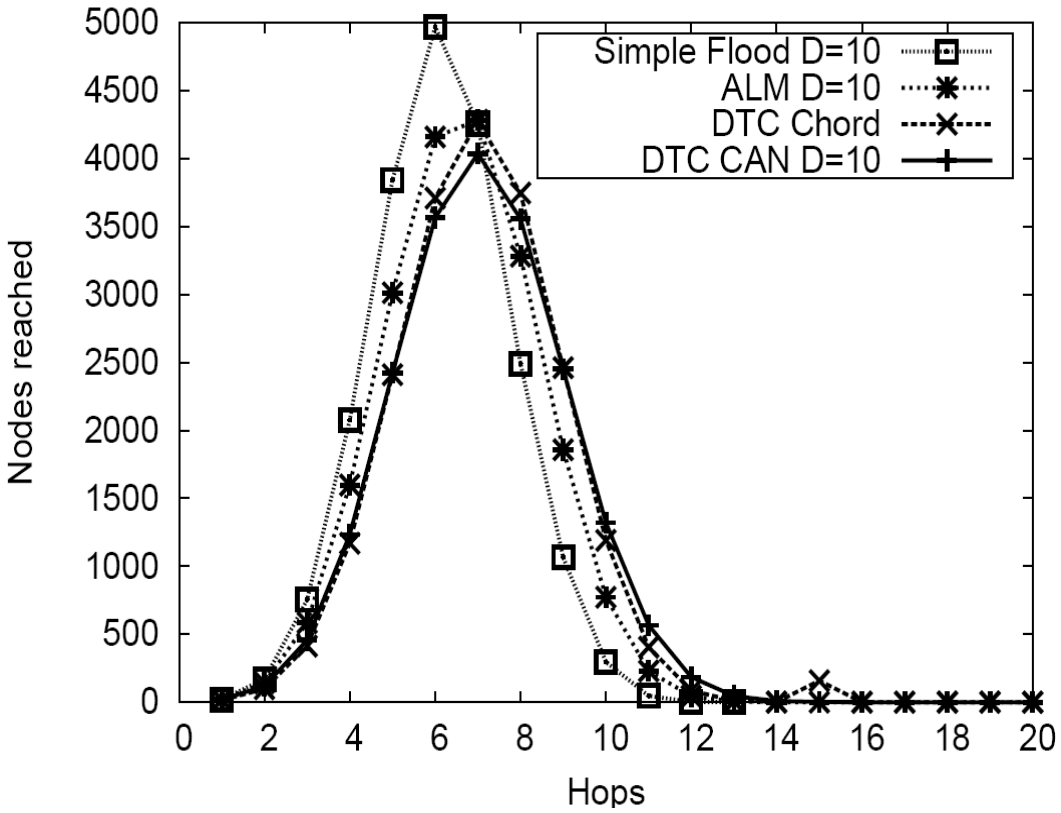
Multicast approach by Ratnasami:

Start from an arbitrary node.

Keep sending north and south until end of ID space.

Then send to your left/right neighbour until end of ID space

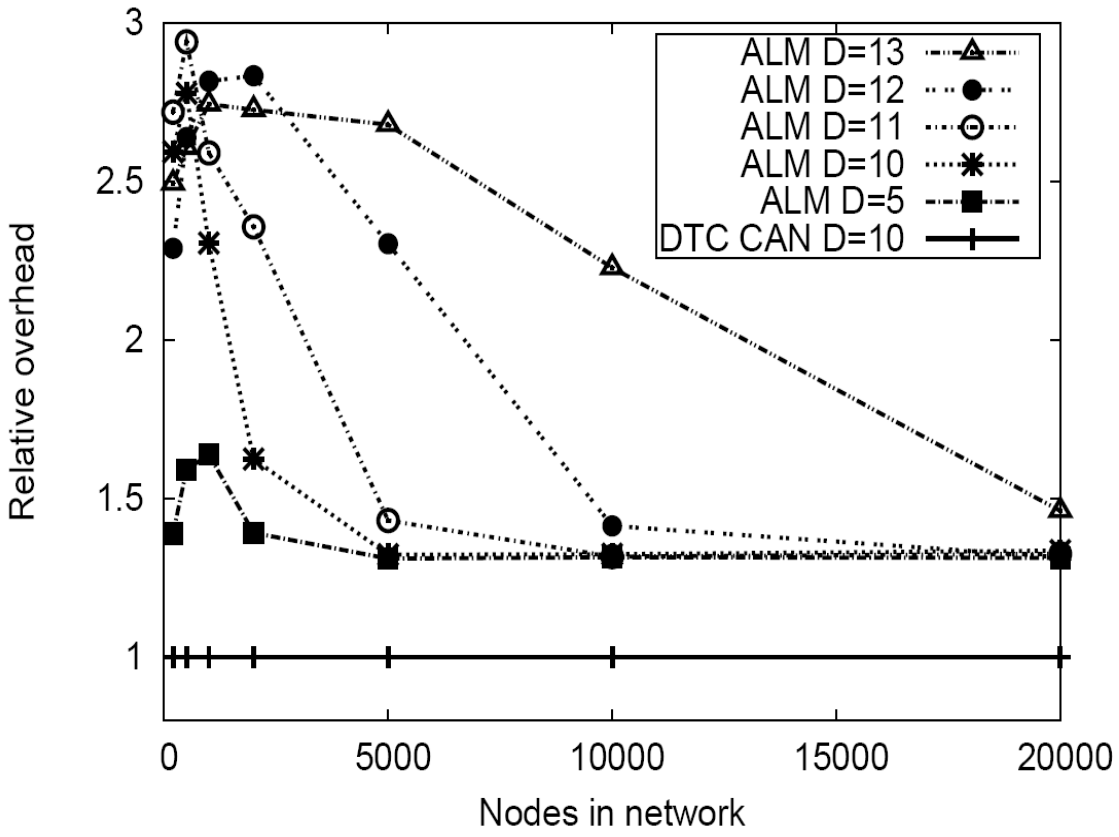
Query Depth



Network properties:
- 20000 nodes
- 10 dimensions
- Averaged over 30 simulations

Simple Flood shows optimal multicast depth. ALM and DTC perform similar.

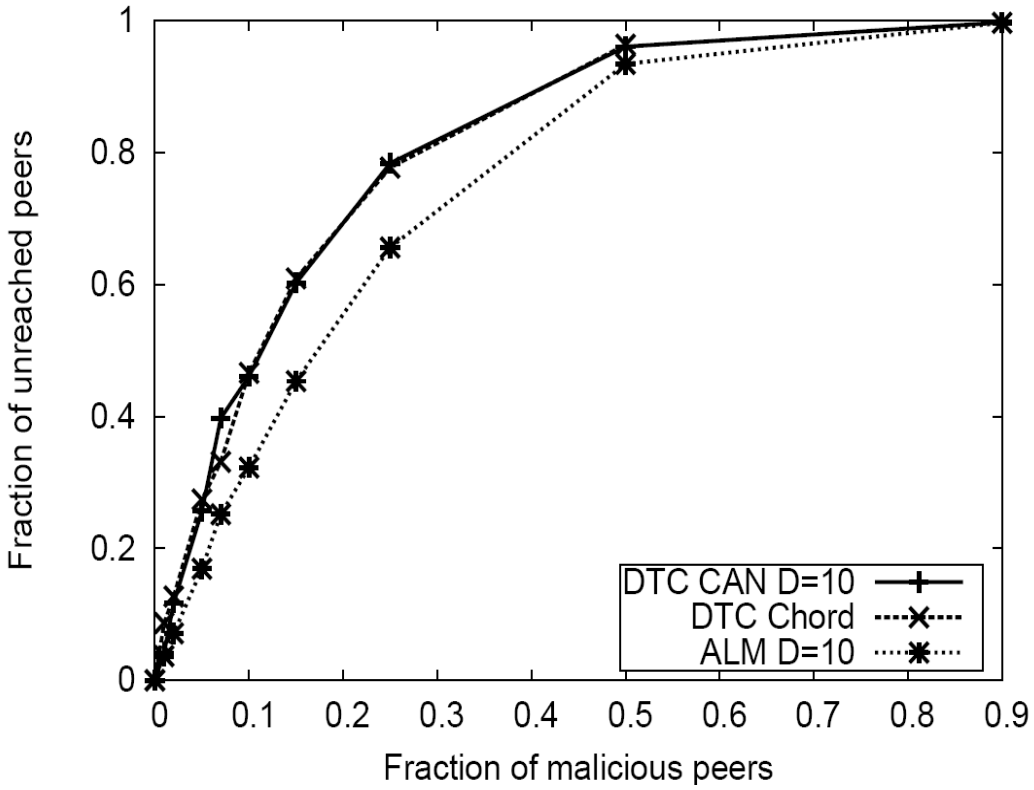
Average overhead of ALM compared to DTC



ALM overhead varies between 1.4 and 3 times the optimal number of needed messages. On large numbers of peers the overhead tends to converge to 1.4.

Overhead tends to stay constant for a high number of peers.

Malicious Peers



DTC is sensitive to attacks.

In case of 20% malicious peers only 50% of the network are reachable with a multicast message.

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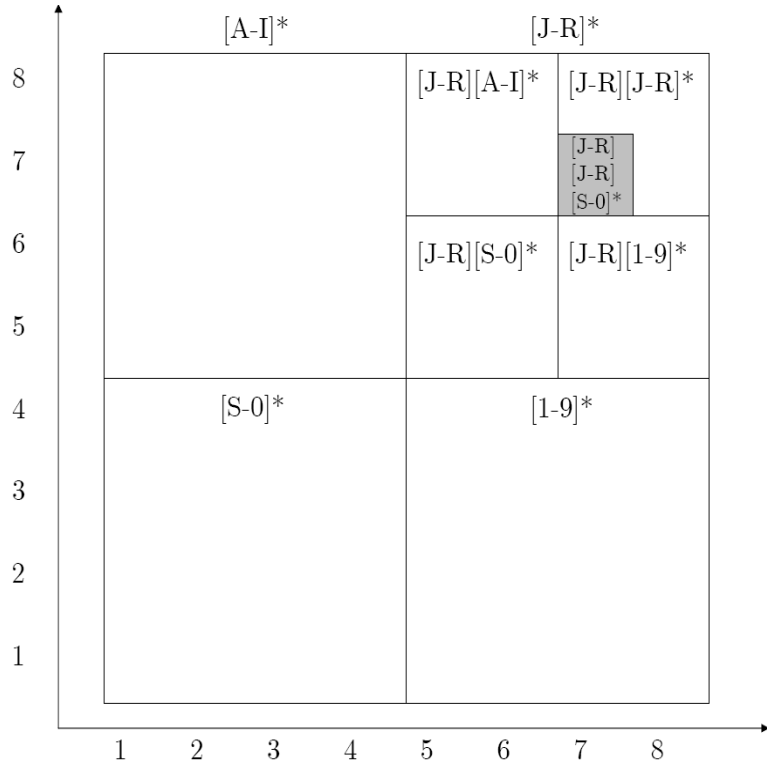
Range queries and Prefix search are in an early testing phase.

Technical report: http://arxiv.org/abs/0808.1207

Basic idea for prefix search:

- Replace hash function with a quad tree
- Perform DTC in a defined subset of the network
- Query results must be located in the subset of the network

Showstopper: Bottlenecks may occur



Questions

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Thank you

Optimally Efficient Multicast and Prefix Search in Structured Peer-to-Peer Networks

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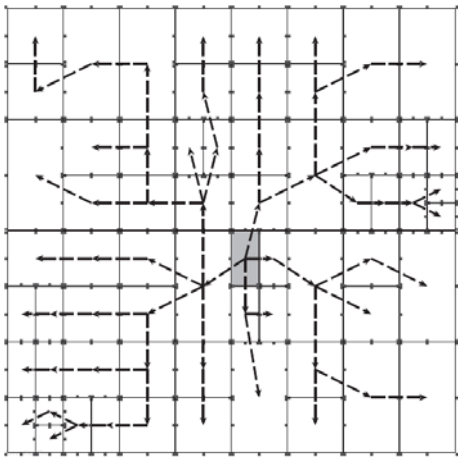
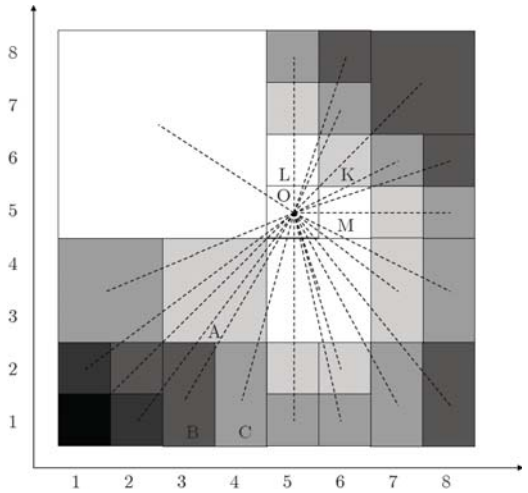
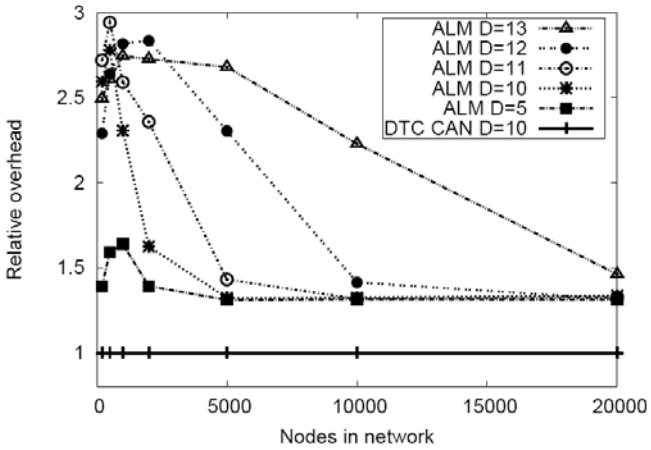
- Application Level Multicast without any duplicates → Minimal amount of messages
- Enables Prefix search in DHTs (tested with Chord and CAN)



Subset of CAN overlay. Multicast is started from marked node and forms a tree.



Peers calculate virtual line between origin (O) and their neighbors.
If an intersection between the peers own zone and its neighbors zone exists the multicast message is forwarded.



Related solutions tend to have a message overhead of >30%.
More dimensions cause higher overhead.

Optimally Efficient Prefix Search and Multicast in Structured Peer-to-Peer Networks
D. Bradler, J. Kangasharju, M. Mühlhäuser, CCNC 2009

PathFinder: Efficient Lookups and Efficient Search in Peer-to-Peer Networks

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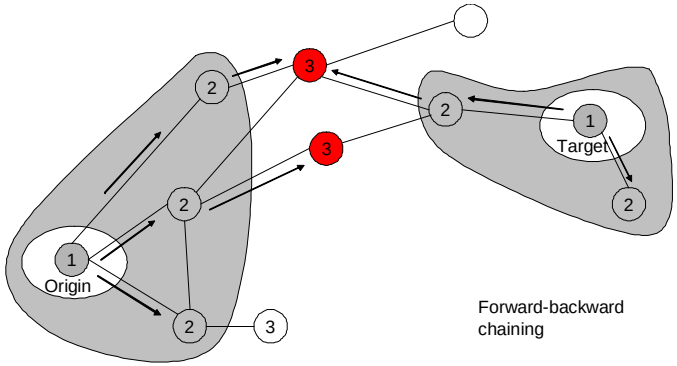
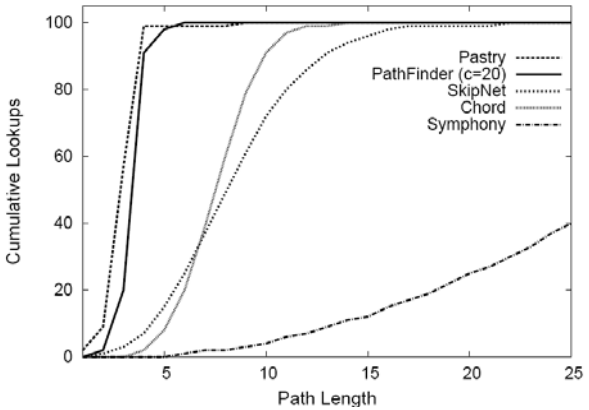
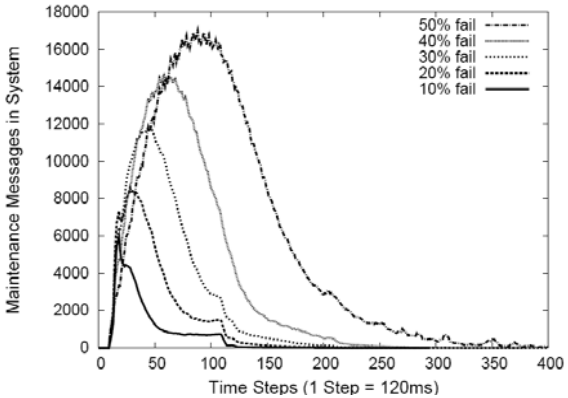
- PathFinder provides low latency DHT lookups with fix number of neighbors.
- Desired random graph properties are preserved.







Idea: Precalculate a path in an Erdös Rényi random graph. It is build using a global known construction rule. Forward-backward chaining finds a match in <30ms for 1mio. nodes.

Cumulative lookups of PathFinder compared to established DHT overlays with 20k nodes.
PathFinder latency comparable to Pastry at 20k nodes but number of neighbors < 1/3.

Recovery time for massive failures (10%-50%) with 10k peers.

DHT is established in less than 60 seconds up to 50% node failures

PathFinder: Efficient Lookups and Efficient Search in Peer-to-Peer Networks
D. Bradler, L. Krumov, J. Kangasharju, M. Mühlhäuser, in submission, Infocom 2009