P-Grid: A self-organizing access structure for P2P information systems

Karl Aberer
Department of Communication Systems
Swiss Federal Institute of Technology (EPFL)
Xiaoli Zhang
lilie0927@yahoo.de

Overview

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2. System Model and Access Structure
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5. Simulation
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1. Introduction

- Peer-To-Peer systems

  -are driving a major paradigm shift in the era of genuinely distributed computing

  -Every node of the system plays the role of a client and a server

P-Grid (Peer-Grid)

- The resulting distributed access structure we call P-Grid.
- is a next generation peer-to-peer platform for distributed information management file-sharing
- is a virtual binary search tree that distributes replication over a community of peers and supports efficient search

P-Grid (Peer-Grid)

- P-Grid's most important properties are:

  -complete decentralization

  -self-organization

  -decentralized load balancing

  -efficient search

P-Grid (Peer-Grid)

- P-Grid's most important applications are:
  - data management functionalities (update)
  - management of dynamic IP addresses and identities

2.System Model and Access Structure

- Assume: address r ∈ADDR we define peer (r) = a iff addr (a) = r for a∈ P
- Peers are online:
- with a probability online: P→ [0,1]
- can be reached reliably using the underlying communication infrastructure by means of their address

Access Structure

- Now we define the access structure (not formally):

 -The search space is partitioned into intervals of the form $I(k), k \in K$.

-Every peer takes over responsibility for an interval I(k).

-The peers have the same prefix of length L, but a different value at position L+1.

-A search can be started at each peer.

Access Structure

- Work in the following way
  - Every peer maintains a small fragment of the set of keys and a routing table
  - The routing tables are organized such that at different levels of granularity requests can be forwarded
  - Replication is used to increase robustness

Access Structure

- The data structure for peers of the P-Grid (formally):

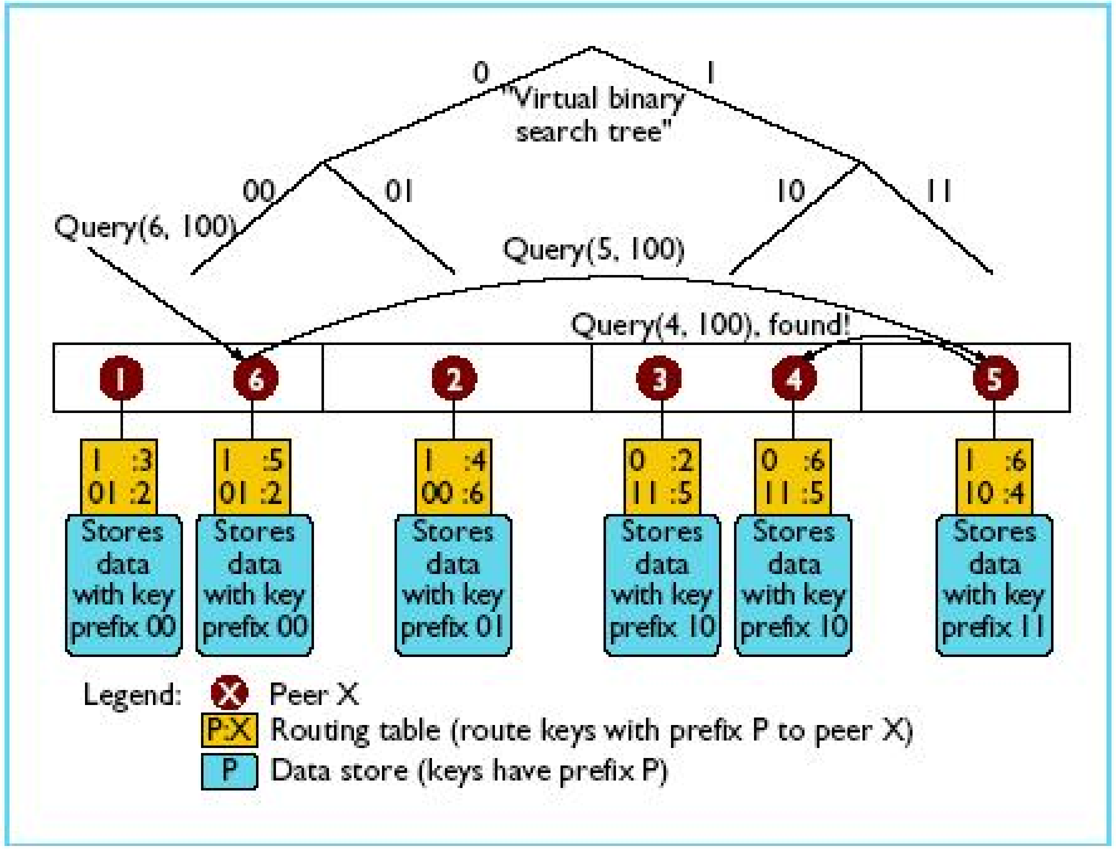
-Every peer a∈P maintains a sequence (p1,R1)(p2,R2)…(pn,Rn), where p1 ∈{0,1} and Ri ⊂ADDR, path (a)=p1…pn,prefix (i,a) =p1…pi for 0<=i<=n and refs(i,a) = Ri.

☆In addition the number of references in Ri will be limited by a value refax.

☆One can see that multiple peers can be responsible for the same key, we call these later also replicas.

☆We bound the recursion depth up to which the exchange function is called by the value recmax.

3.The P-Grid Search Structure



3.P-Grid Distributed Search Structure

- ☆ it is completely decentralized;
- ☆ all peers serve as entry points for search;
- ☆ interactions are strictly local;
- ☆ it uses randomized algorithms for access and search;
- probabilistic estimates of search request success can be given;
- search is robust against node failures; and it scales gracefully in the total number of nodes and data items.

4.P-Grid Construction

- No global control ,only by local interactions
- Meet randomly
- Initially, all peers are responsible for all the search keys.
- When two peers meet, they decide to split the search space into two parts and take over responsibility for one half each, also store the reference to other peer.
- The same happens whenever two peers meet, that are responsible for the same interval at the same level.

4.P-Grid Construction

- Namely, peers will meet

  1 , their keys share a common prefix,

  2, their keys are in a prefix relationship.

☆ As many peers can be responsible for the same key the general problem is of how to find all those peers in case of an update. Different strategies are possible:

  1, depth first search

  2, breadth first search

  3, search with buddies

5. Simulation

- Implementation in Mathematica(www.wolfram.com)
- Questions:

1, How many communications in terms of executing the exchange algorithm are required for building a P-Grid ?

2, How balanced the P-Grid is with respect to the distribution of keys?

3, How reliably updates can be performed?

5. Simulation

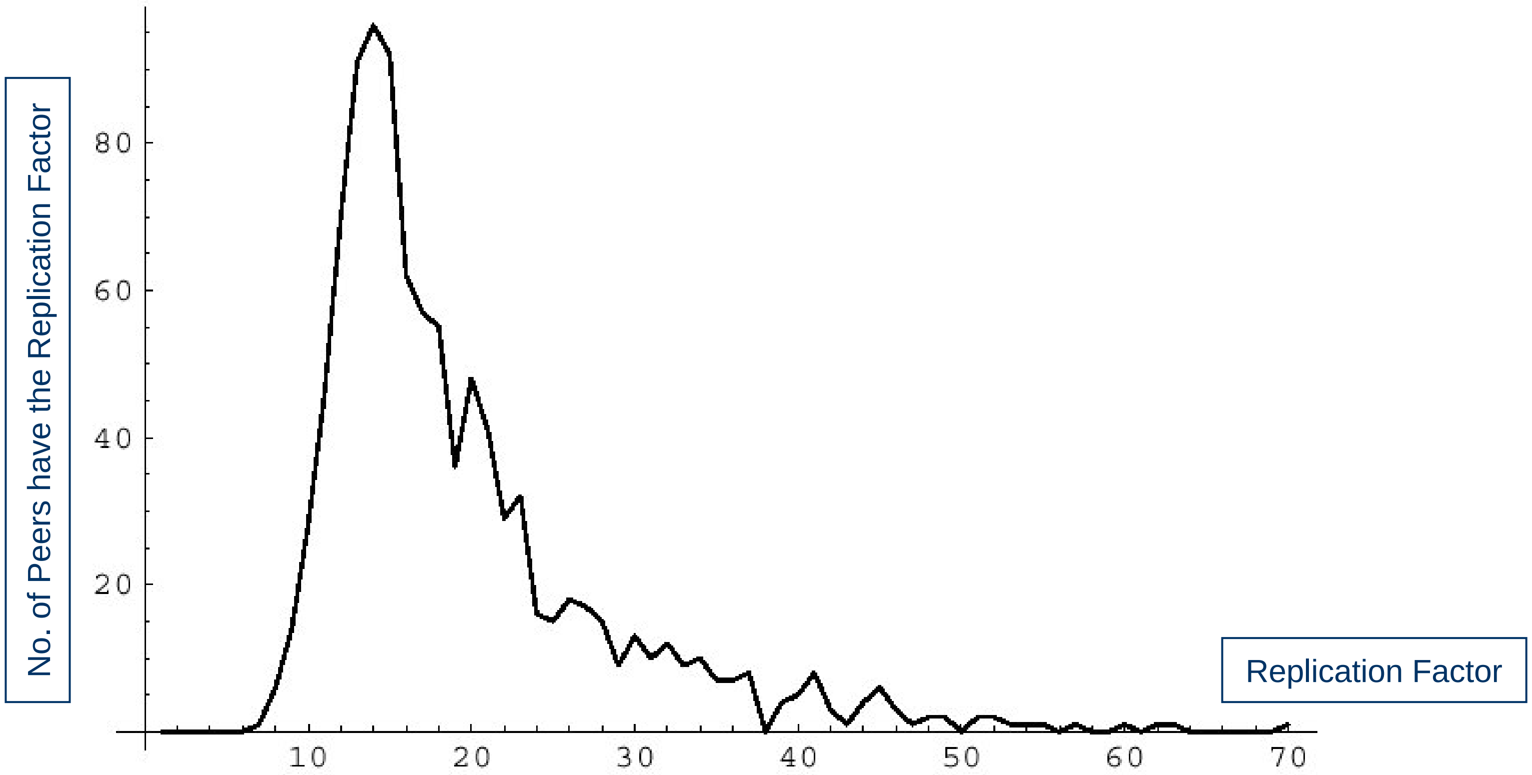
- Question 1

The results indicate that a linear relationship exists between the number of peers (N) and the total number of communications (e) needed in building the P-Grid.

	recmax = 0		recmax=2	
N	e	$\frac{e}{N}$	e	$\frac{e}{N}$
200	15942	79.71	4937	24.68
400	27632	69.08	10383	25.95
600	43435	72.39	15228	25.38
800	59212	74.01	18580	23.22
1000	74619	74.61	25162	25.16

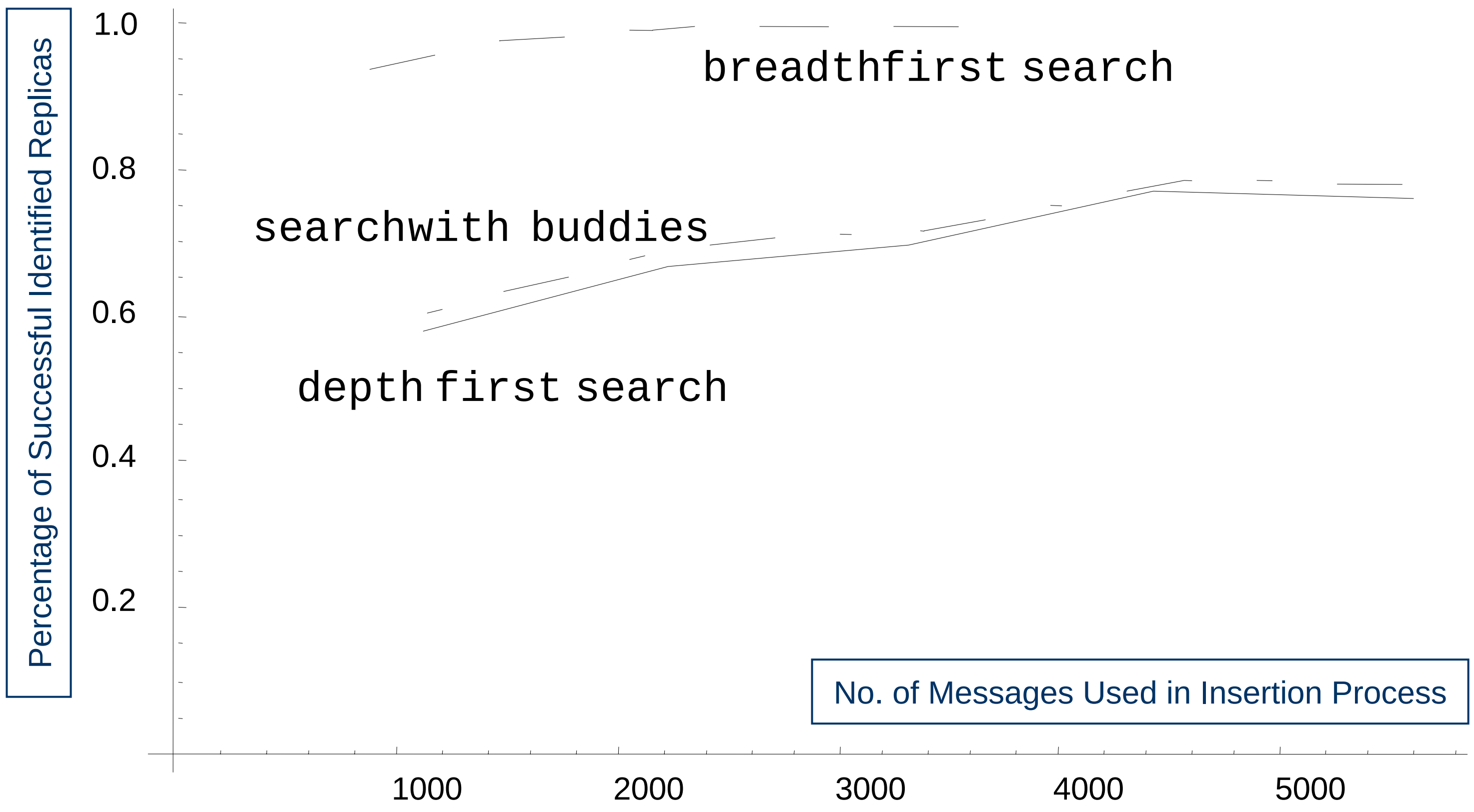
Replica distribution

- *Question 2 : The average number of replication for a peer is 19.46.*



Finding all replicas-result

Question 3 :Using breadth first searches is by far superior.



6. Conclusions

- Scalable distributed and decentralized access structures are possible
- P-Grids offer a lot of flexibility to be further exploited
- Foundation for many fully decentralized P2P applications
- Application in mobile ad-hoc networks (www.terminode.com), Swiss national research centre at EPFL

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