Institute of Computer Science
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Freie Universität Berlin

Algorithms and Programming IV

DHT-based P2P-Systems (20-3)

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Peer-to-Peer

- Ressources are shared between the peers.
- Resoources can be accessed directely from other peers.
- Peer is provider and requester (servent concept).

Unstructured Overlay

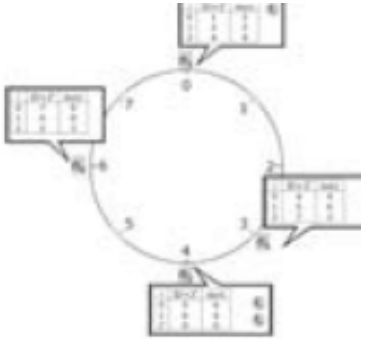
Centralized P2P

Pure P2P

1st Generation

Structured Overlay

DHT-based



- All features pf P2P included
- Any terminal entity can be removed without loss of functionality
- No central entities
- Connections in the overlay are fixed
- Example: Paestry, Chord, CAN

Peer-to-peer systems

PASTRY

Introducing Pastry

- P2P overlay that is using Dynamic Hash Tables (DHT) with prefix-based routing with both peer ID and object ID.

- Prefix routing narrows the search for the next node along the route by applying a binary mask that selects an increasing number of hexadecimal digits from the destination GUID after each hop.

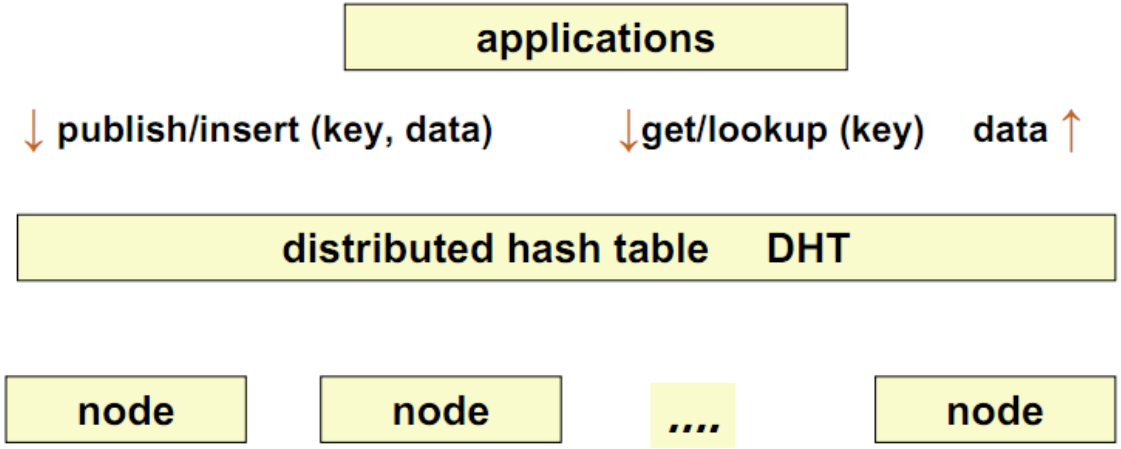
- It is originally developed Microsoft and Rice Uni but a free version (FreePastry) exists that is a prototypical implementation of Pastry. The latter is mostly used by scientific community.

- Similar algorithms are Chord and CAN.

Introducing Pastry (*cont.*)

- Any computer connected to the Internet and running PASTRY node software can be a PASTRY node.
- Application specific security polices may be applied.
- Each node is identified by a unique 128 bit node identifier (NodeId).
  - The node identifier is assumed to be generated randomly
  - Each NodeId in is assumed to have the same probability of being chosen
  - Node with similar NodeId may be geographically far

Mode of Operation of a Distributed Hash Table



lookup(key) -> node or data directly

Lookup where it is stored

every node stores and maintains part of hash table

every object / resource has a (hash) key which is stored at the node responsible for its key

Distributed Hash Table: Steps of Operation

1. Mapping of nodes and data to the same address space
   - Peers and content are addressed using flat identifiers (IDs)
   - Common address space for data and nodes
   - Nodes are responsible for data in certain parts of the address space
   - Association of data to nodes may change since nodes may disappear

2. Storing / Looking up data in the DHT
   - “Look-up” for data = routing to the responsible node
   - Responsible node not necessarily known in advance
   - Deterministic statement about availability of data

Sketch of the Routing Algorithm

- Assume we want to find the node in the PASTRY network with the NodeId closest to a given key.

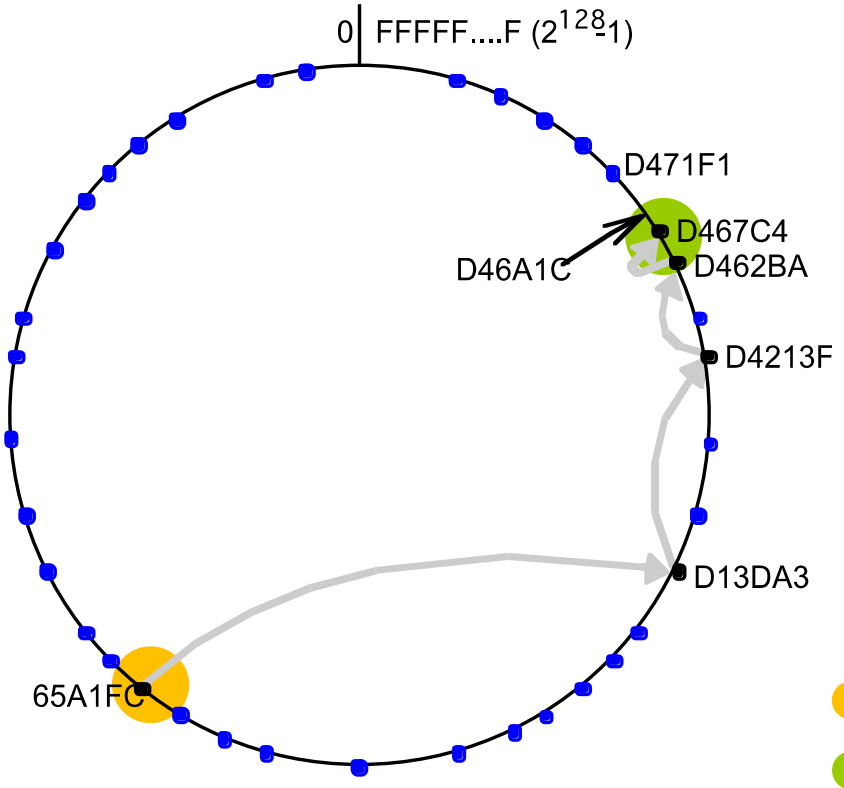
Routing Idea

In each routing step, a node normally forwards the message to a node whose NodeId shares with the key a prefix that is at least one digit longer than than the key shares with the present node. If such a node is not known, the message is forwarded to a node that shares the same prefix of the actual node but its NodeId is numerically closer to the key.

First Four Rows of a Pastry Routing Table

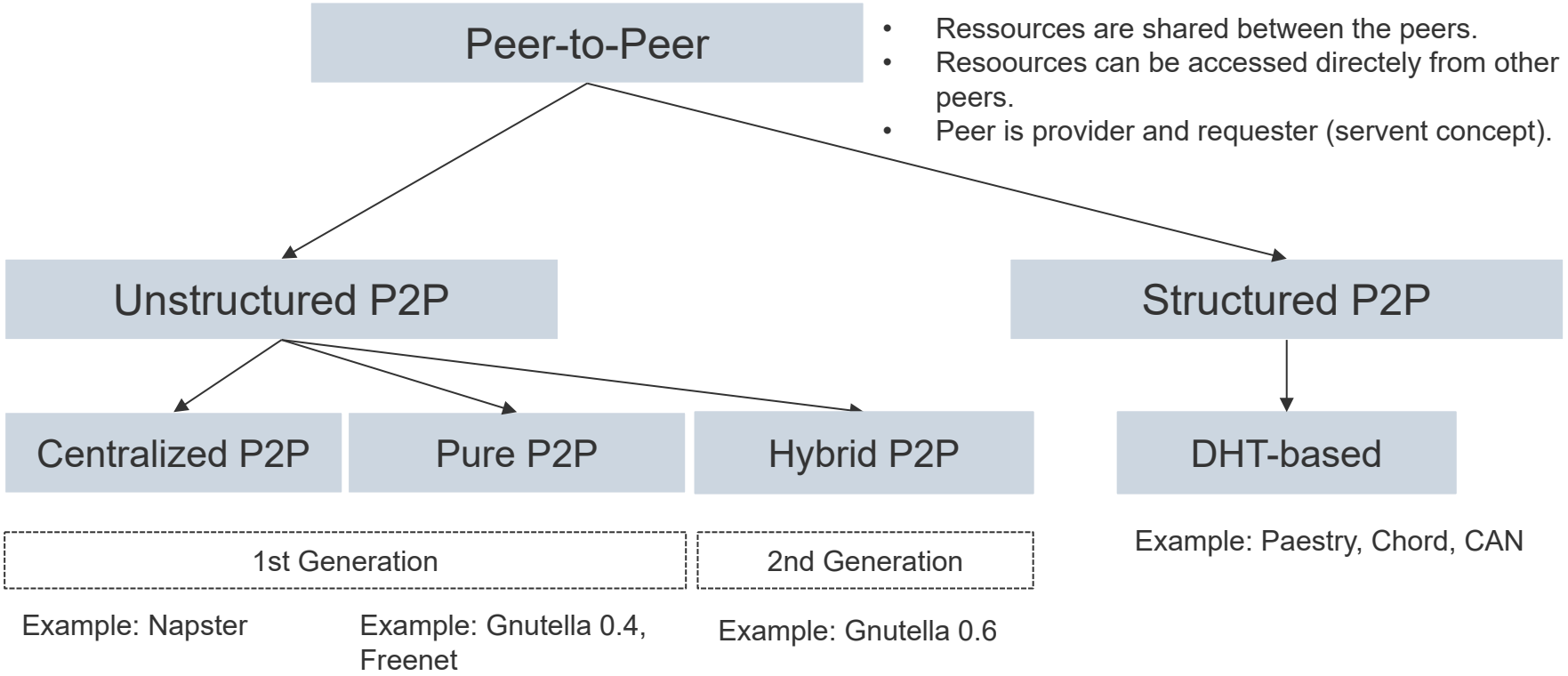
p =	GUID prefixes and corresponding nodehandles n															
0	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
	n	n	n	n	n	n		n	n	n	n	n	n	n	n	n
1	60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6F	6E	6F
	n	n	n	n	n		n	n	n	n	n	n	n	n	n	n
2	650	651	652	653	654	655	656	657	658	659	65A	65B	65C	65D	65E	65F
	n	n	n	n	n	n	n	n	n	n		n	n	n	n	n
3	65A0	65A1	65A2	65A3	65A4	65A5	65A6	65A7	65A8	65A9	65AA	65AB	65AC	65AD	65AE	65AF
	n		n	n	n	n	n	n	n	n	n	n	n	n	n	n

Pastry Routing Example



Source NodeID **65A1FC**

Destination NodeID **D46A1C**



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References

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Routing in Unstructured Overlay Networks: Flooding vs. Random Walk