Self-adaptive Route Selection for DHT in Wireless Sensor Networks

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Using distributed hash tables (DHTs) over wireless sensor networks (WSNs) as the overlay layer has gained much attention recently because of its well designed topology and efficient data management [1]. The data of sensor nodes are stored in the overlay network, which ensures the data integrity against node failures. Nodes in a WSN are randomly deployed and may switch to sleep mode or fail due to the energy depletion, which results in changes of the network topology. Retrieving data is therefore a challenging task in such distributed and varying environments. Query latency is the most important performance metric in DHT and may not be proportional to the hop count along a route. *Proximity neighbor/route selection* (PNS/PRS) are used to find the shortest route and reduce latency based on the basic DHT routing. However, most existing works on PNS and PRS suffer from high overhead and frequent node arrival and departure (churn). Therefore, we propose a proximity-aware routing algorithm based on Pastry [2], dubbed Pastry-AS, to provide self-adaptive selection of routes and neighbors based on *attractor selection* [3], a biologically inspired model which operates well in ambient and fluctuating environments. Attractor selection performs a stochastic adaptation of its system state taking into account environmental changes by to an *activity* term, and converges to a stable state known as an *attractor*.

In Pastry, each node has a unique ID and maintains a leafset and routing table, which corresponds to the partition of the node ID space. We propose a *redundant routing table* (RRT) to implement both route selection and parallel query forwarding. A passive routing table maintenance scheme is used to piggyback the routing information onto the query requests and ACKs. Only *r* candidates with IDs within a particular range are stored in the RRT entry as possible states, among which attractor selection is performed inspired by the equations in [3]. The performance of the selected route, such as the measured RTT, is mapped to the activity and influences the next selection. Finally, an attractor is selected from close-by neighbors. Since the topology of WSNs is always changing, whenever a node discovers new neighbors or their departure, the activity becomes low and drives the node to search for a new attractor solution. Thus, a low latency is achieved after several selections without any explicit probing and it is also maintained under churn. Parallel query forwarding is enabled by the nodes with sufficient bandwidth to achieve less timeouts and quick dissemination of the routing information. Compared with the original Pastry, we expect Pastry-AS to achieve lower latency in routing and less overhead in the routing table maintenance. In a dynamic network, RRT and parallel forwarding achieve a very low probability of timeouts, which further reduces the latency.

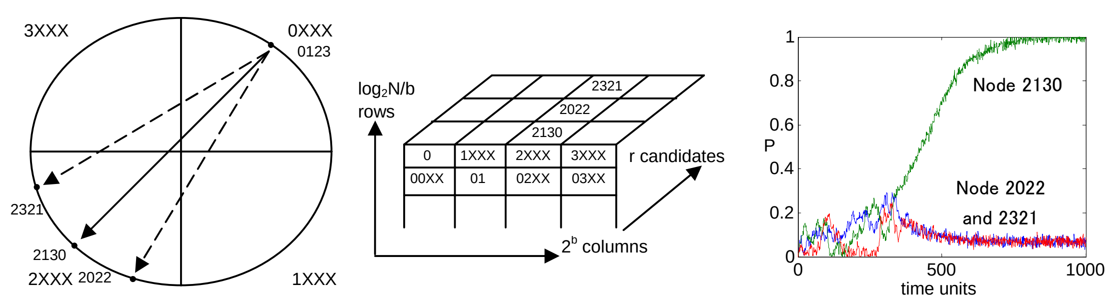

Figure 1. Left: partition of Pastry node ID space (b=2). Node 0123 selects three neighbors in the ID range 2xxx, whereby Node 2130 is the selected route. Node 2022 and 2321 are used when parallel forwarding is enabled. Middle: RRT of Node 0123. Extending the original Pastry routing table, each entry has *r* candidates which share the same prefix. Right: Route selection probability P. After the random walk period, Node 2130 achieves the best performance and is selected with a high probability.

References

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Type of Presentation : Poster

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