Efficient Routing and Data Management in Sensor Networks using Virtual Cord Routing (VCP)

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1. INTRODUCTION

We show the feasibility of efficient routing and service discovery in sensor networks using the Virtual Cord Protocol (VCP). Scalable and energy efficient data management is still a challenging topic in this domain. This problem domain is being addressed by recent Distributed Hash Table (DHT)-based approaches for data management in Wireless Sensor Networks (WSNs). In general, such solutions can be classified in three main categories: real location based, virtual location based, and location independent, whereby the most recent approaches for data management and routing in WSNs rely on virtual coordinates. Inspired by DHTs and bringing this idea down to the underlay, efficient routing paths can be maintained together with the capability to store information and data in a DHT-like system. The first solution in this field has been Virtual Ring Routing (VRR) [1]. It uses a location independent unique key to identify nodes and to organize them into a virtual ring. The problem of this protocol is that the adjacent nodes in the ring can be far away in the real network. Moreover, dead ends cannot be completely prevented. Later on, VCP has been proposed, which shows a couple of advantages compared to VRR [2]. The concept of the protocol always ensures reachability of all destinations and optimizes routes on the fly by exploiting information about physical neighbors. Using the concept of indirections, VCP also provides efficient resource and service discovery.

This demo shows the applicability of VCP for efficient routing and data management in sensor networks. After evaluating the protocol using comprehensive simulation studies in previous work [2, 3], we implemented the protocol on the BTnode sensor node platform, which is based on an Atmel ATmega128 micro controller and a CC1000 radio transmitter. We show the feasibility of the protocol implementation in a small but easy to understand demo scenario. For demonstration purposes, we visualize the established cord and its dynamic updates as shown in Figure 1.

2. VIRTUAL CORD PROTOCOL

Virtual Cord Protocol (VCP) exploits the concepts of DHTs to combine data management with efficient routing in sensor networks. The main idea is to arrange all the nodes in the network in form of a virtual cord. The topology of this cord must not be "optimal" in any sense because routing is organized by exploiting information about the physical neighbors for greedy forwarding. Nevertheless, the cord ensures a connection between any two nodes. An application-dependent hash function is used for associating data items to nodes. Thus, both the push and the pull principles are supported – pushing to a node and pulling data from a node. The same concept can be used for reliable service discovery.

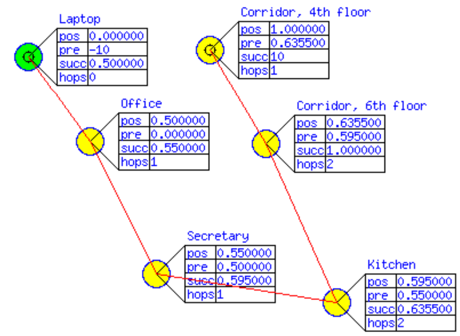

Figure 1: Cord visualization in the lab demo

The cord setup and routing procedure is outlined in detail in [2]. The setup relies on a single "initial" node. Any further joining node detects the local neighbors by means of a hello-exchange. Using the received information about the current state of the cord, the new node can jopin the cord by creating a new address and updating the routing table from its two adjacent virtual cord neighbors. Routing is performed by exploiting locally available knowledge about the direct neighbors. Shortcuts can be used to greedily route towards the destination. The cord serves as a fallback solution that always provide a path to the destination. In simulation experiments, we have shown that the resulting path is almost optimal and VCP clearly outperforms similar solutions.

Data management are handled by the protocol inherent capabilities to identify virtual coordinates of "items" in the network. An application-dependent hash function is used to hash specific data to nodes in the network. This functionality supports the classical push and pull principles to access data in a WSN, i.e. the hash value of an identifier can be used to store data in the cord or to retrieve data, respectively.

3. REFERENCES

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