Master Thesis Philipp Huppertz : "Routing in a small Wireless Sensor Network"

Motivation

Routing in Wireless Sensor Networks (WSNs) is still an open research field. Many protocols have been designed and evaluated using simulation tools. Only a few have been tested in real world scenarios. This turns out to be a problem for the evaluation of these protocols. In [1] it is shown that the results of simulation studies not always reflect the results measured in real world scenarios. Contrary to simulations routing in a real world WSN applications is not the main task for a WSN. Only a fraction of the already limited resources (like RAM and CPU cycles) of a sensor node can be used by the routing protocol.
As a consequence the implementation and evaluation of a real world sensor application using different routing approaches can produce new insights for routing in WSNs.

Constrictions and Goals

The goal of this thesis is to develop and evaluate different on-demand routing approaches for the Signal Processing Intelligent Sensor Applications (SPISA) project. The routing approaches themselves should be general purpose which means that they can be used for a wide range of applications. Furthermore only small WSNs are considered (< 10 nodes). Besides the different routing approaches an example application for creating distinct scenarios and for collecting measures has to be implemented.

State of the Art and detailed Problem Description

The implementation can be broken down into two main tasks:
1) The implementation of a realistic application for creating traffic in the WSN and collecting and storing measurements concerning the routing for evaluation purposes. The application collects data and transfers it to a given node in the network. To control the collection and data transfer an application on a Personal Computer (PC) connected to a node can issue commands to the WSN. The application on the PC should be able to collect routing information and measurements from the nodes. This data is used to evaluate the different routing approaches for a given scenario. The SPISA project already provides the main building blocks for a "real-world" WSN application. There is a module for collecting and processing audio data. For data storage and measurement collection a module utilizing a SD Flash card can be used.
2) The implementation and evaluation of routing approaches. For the routing approaches flooding (rebroadcasting) and other routing protocols based on the well known general purpose Dynamic Source Routing (DSR) [2] and Ad-hoc On-demand Distance Vector (AODV) [3] are taken into consideration. It is not intended to implement the above complete standards / drafts and their features. A sub task is to adopt the basic features of AODV and DSR and modify them to the special requirements of WSNs (low memory, low computational overhead and low power). The SPISA platform provides a Carrier Sense Multiple Access (CSMA) (using a RTC / CTS scheme) Media Access Control (MAC) upon which the routing approaches can be built.

Evaluation and Measurements

The implemented routing approaches are compared and evaluated after taking measures for different scenarios. These data transfer scenarios consist of:
- Single sender and single source (one route)
- Single sender and multiple sinks (multiple routes)
- Multiple senders and one sink (multiple routes)
- Multiple sender and multiple sinks (multiple routes)

All scenarios are static (no mobility of nodes) although data transfer is not constant and routes should be build up dynamically on-demand. To control the scenario a node connected to a PC can issue commands to the WSN and induce data transfers between nodes.
The measurements of the routing approaches should consider:
- Code size / RAM size
- Overhead of protocol in bytes / packets
- Lost packets
- Amount of sent and received packets (energy consumption)
- Throughput
- Delay (route construction)

The measured data is collected by a PC connected to a node of the WSN. This data is used a for the evaluation under different aspects like performance and robustness.

Tasks and rough Time-line

1. Seeking literature and choosing the routing approaches (2 weeks)
2. Implementation of first routing approach (plain flooding) (1 week)
3. Implementation of example application (2-3 weeks)
4. Implementation of other routing approaches (based upon DSR and AODV) (2-3 weeks)
5. Taking measurements and evaluation (3 weeks)
6. Finish writing of thesis (4 weeks)

References

[1] Kiess, W. and Mauve, M.
A survey on real-world implementations of mobile ad-hoc networks
2007
[2] Johnson, D.B. and Maltz, D.A. and Broch, J. and others
DSR: The Dynamic Source Routing Protocol for Multi-Hop Wireless Ad Hoc Networks
2001
[3] C. Perkins, E. Belding-Royer, S. Das
Ad hoc On-Demand Distance Vector (AODV) Routing
2003