Unsynchronized Energy-Efficient Medium Access Control and Routing in Wireless Sensor Networks

Philipp Hurni

Institute of Computer Science and Applied Mathematics
University of Bern, Switzerland
hurni@iam.unibe.ch

This master thesis investigates optimizations on recently proposed fully unsynchronized power saving sensor MAC protocols. In contrast to many other sensor MAC protocols, unsynchronized sensor MAC protocols renounce on any kind of network- or cluster-wide synchronization for channel access coordination and maintenance of a common wake-sleep pattern, because in wireless sensor networks with low traffic requirements, the overhead for maintaining synchronization is likely to exceed the energy spent for the actual data traffic.
The implementation of the unsynchronized power saving protocol WiseMAC in a simulator and on real sensor hardware forms the entry point of the master thesis. The thesis discusses the choice of appropriate and realistic parameter values for the simulator environment and WiseMAC simulation model by comparing the protocol performance in simulation and on real hardware.
We suggest optimizations of the broadcast operation mode of WiseMAC to achieve a higher energy-efficiency. We exploit local knowledge of the neighboring nodes' wake-up schedules. Experiments in simulation and with the real-world prototype implementation approve the superior energy-efficiency of the scheme further called *best-instants broadcast* compared to existing techniques.
We propose an alternative allocation and arrangement scheme of the node's wake-up intervals is discussed to avert performance degrading systematic overhearing and fairness effects of WiseMAC's fixed static wake-up pattern, as problems may arise when two neighboring nodes share a similar wake pattern. We developed a scheme to let the nodes' wake-up window move in-between fixed intervals in respect to a linear movement-function, which leads to a more reliable overhearing avoidance and a lower risk of systematic overhearing, yet retaining the deterministic nature of the wake-ups.
We outline a mechanism to improve the adaptivity of the WiseMAC protocol in cases of traffic between multiple senders and one receiver basing on a so-called stay-awake promise. Cases with multiple nodes aiming to forward data over certain receivers are likely to occur in wireless sensor network topologies. Bottleneck nodes often have to forward data of large subtrees. Experiments on the simulator approve performance gains in respect to throughput and latency.
On the routing layer, the thesis integrates the on-demand routing protocol AODV and evaluates the performance of the combination with the energy saving MAC. Efforts are undertaken to integrate a multipath-protocol to balance load in a wireless sensor network and achieve a higher network lifetime.