Report on PerAda Researcher Funding

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1 Outline of Visit

The purpose of the visit of Tobias Baumgartner from Braunschweig Institute of Technology (TUBS), Germany at Universitat Politècnica de Catalunya (UPC), Barcelona, Spain, was to bridge the gap between theory and practice. Hugo Hernández has developed a method for dynamic duty-cycling in wireless sensor networks [4, 6, 5] that works on a profound theoretic basis. Tobias Baumgartner is the main developer of the Wiselib [1, 8], an algorithm library for sensor networks where an implementation can be brought to both real sensor nodes and simulation environments. The purpose of the collaboration is to translate and adapt the duty-cycling protocol to realistic environments.

2 Exchange Visit in Barcelona

During the visit at UPC, Barcelona, Tobias Baumgartner and Hugo Hernández worked on the adaptation of the duty-cycling protocol to the Wiselib, since the algorithm was previously only evaluated without considering, for example, message loss and collisions. Having the algorithm in the Wiselib, it is possible to run the same implementation in sensor network simulators offering simulation of message loss and collisions (in our case: Shawn [7]) and even on real sensor nodes.

The duty-cycling algorithm is based on ant algorithms—or rather inspired by self-synchronized sleeping patterns of ant colonies. It was designed for sensor nodes with energy-harvesting capabilities, as, for example, iSense [2] nodes equipped with solar power harvesting modules. The nodes automatically adapt their sleep schedules to their battery level, and thus are more often active during day (when the sun is usually shining) than at night. The algorithm also synchronizes the wake-up times, so that at regular time intervals, all nodes in the network are active. The idea is indicated in Figure 1, where the average node activity in a simulation run is shown (the figure is a result from our collaborated work).

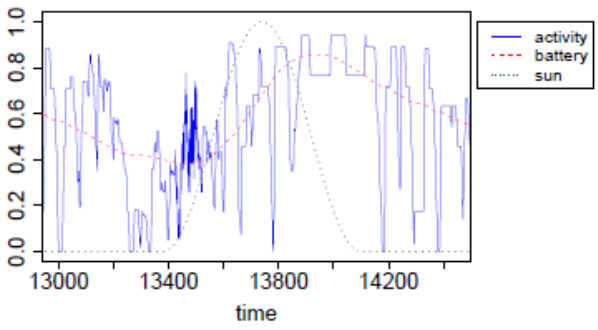

Figure 1: Simulation results with a network size of 120 on the 11th day. Solid line: fraction of active nodes. Dashed line: average battery level. Dotted line: sun light intensity.

Since we had to re-write the whole algorithm from scratch, the goal within this week was to have the implementation running in the simulator, and to obtain first results from simulation. Hence, the first three days of the visit were only spent for planning the adaptation of the algorithm, and the implementation. In the last two days, we evaluated the algorithm and obtained first results. All of the work in this week was done in Shawn. Bringing the algorithm to real testbed was planned for the second exchange, on Hugo Hernández' visit in Braunschweig.

When evaluating the algorithm, we added parameters (energy consumption, energy harvesting, battery levels) measured on real nodes, so that the simulation is as realistic as possible. We also ran the duty-cycling algorithm in different environments, evaluating packet loss rate, cloud density (where nodes can not harvest energy as fast as with direct insolation), and network size. The results are shown in Figure 2.

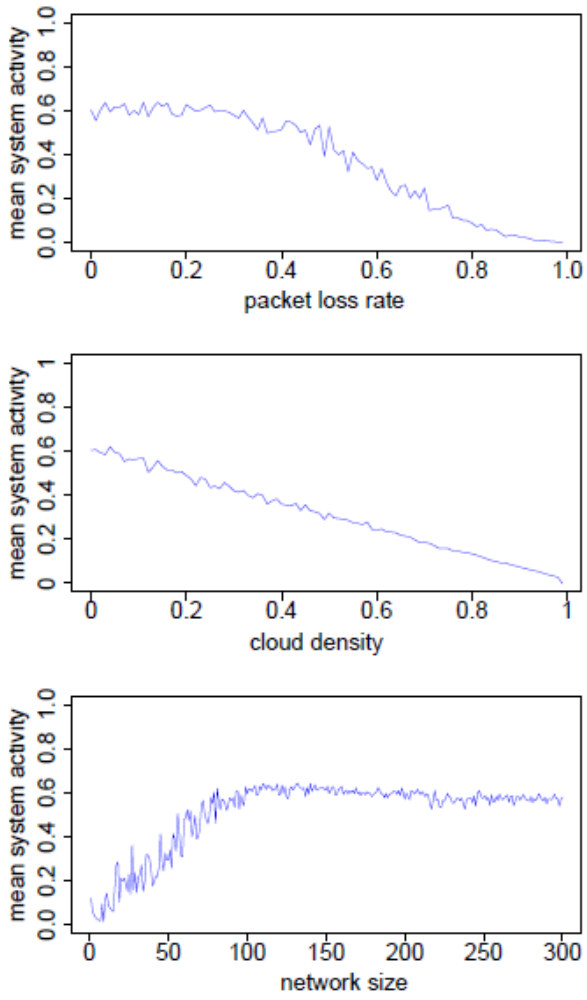

Figure 2: Behavior of the duty-cycling mechanism under varying conditions. Top figure: different packet loss rates. Middle figure: different cloud densities. Bottom figure: different network sizes.

3 Summary

The visit would not have been possible without the PerAda researcher funding. So far, the collaboration resulted ion one paper [3], where we presented the above indicated results.

However, so far we only evaluated the algorithm in a simulator, running in a static network. There will also be a visit from Hugo Hernández in Braunschweig, where we expect to do two extensions:

- Running the algorithm on mobile nodes in the simulator
- Bringing the algorithm to the testbed located in Braunschweig, and thus testing it on real node hardware

References

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