A DTN/WSN infrastructure for data distribution and environmental monitoring in communication challenged areas

Final Report

Peter Sjödin, KTH (project manager)
Markus Hidell, KTH
Robert Olsson, KTH
Björn Pehrson, KTH
Pehr Söderman, KTH

Background

The target scenario for this project is remote sensor networks located in isolated areas with very limited possibilities for communication with the surrounding world. The project aims at tapping of data from such isolated Wireless Sensor Networks (WSNs) using infrastructure-less communication services, such as Delay Tolerant Networking (DTN) store and forward approaches.

Current algorithms for store-and-forward buffer management are not well suited for the purpose of tapping measurement data from sensor nodes. During congestion, common buffer policies such as FIFO and FILO give priority to delivering data based on age – with FIFO, for instance, old data gets priority over new. This might work well for ordinary applications, but not for the kind of environment monitoring applications for which wireless sensor networks often are designed. For environment monitoring, it is crucial to be able to capture variations and patterns on a long-term scale, as well as to detect short-term trends and events.

The project plan included three main parts:

2. Sensor platforms for energy-efficient motes.
3. Planning for further development and industrial partnerships.

Scientific Results

The project resulted in a buffer management algorithm based on Quality of Information (QoI) for wireless sensor networks where measurement data is gathered by mobile DTN nodes (“mules”). The algorithm was evaluated in a setting with DTN routing protocols (ProPHET) and real sensor data as input, and comparisons were made with existing other algorithms. The evaluation indicates that the algorithm has considerable advantages compared to existing approaches when it comes to maintaining QoI of measurement data, as well as concerning implementation complexity.

The platform activity aimed to design and evaluate energy-efficient sensor platforms running open-source platforms, with a variety of sensors including measurements of voltage, current, temperature, humidity, light and pressure. In this area, a sensor platform has been designed and evaluated as a prototype of an IoT-controlled DC-DC converter for nanogrids, and a low-power packet switch.

Industrial Partnerships
Work has been initiated to prepare a Vinnova proposal in the area of “Green IoT”, with wireless sensor networks for air pollution monitoring as the main application area. In the first stage, it is a joint effort between KTH and Uppsala University, and a consortium is being formed with the goal to submit an application in January 2015 for stage two of the Vinnova call “Utmaningsdriven innovation”. In addition to KTH and Uppsala University, the following partners are currently involved:

- 4Dialog (SME, 4D modeling and visualization for urban planning)
- Upwis (SME, wireless sensors)
- City of Uppsala (Uppsala kommun)
- Swedish ICT/SICS
- Ericsson Research

Publications


Concluding remarks

The scientific direction of the project was somewhat revised in relation to the original proposal, partly due to the fact that one of the original proposer, Hervé Ntareme, was replaced by Pehr Söderman. The focus of the work on QoS-based routing has been on algorithms for buffer management. Although a minor change in focus, this allowed the project to make original contributions by exploring a novel approach for buffer management. A future direction of this work is to proceed with experimental evaluation in a real-world scenario, and it is one of the objectives for the consortium working with the Vinnova proposal on Green IoT to establish such an environment.