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Energy Awareness in Wireless Sensor Networks: Communication protocols and Sensor Selection integration

Problem description

Wireless sensor networks (WSNs) are systems of tiny, battery-powered devices, dubbed sensor nodes, that can sense the environment and report the collected sensor readings to one or more collectors. Typical application scenarios for WSNs include environmental and heritage monitoring as well as precision agriculture or manufacturing processes optimization. In most cases, the network acquires a vast amount of data and must then report it wirelessly to a central collector (typically a personal computer), which is in turn able to communicate with one or more sensors of the network. Due to the high energy cost of wireless communication, it is crucial, to enhance network lifetime, to limit the amount of data transmitted throughout the network and, thus, to opportunely select which nodes should participate in the sensing task and which could instead stay idle and save resources. Existing approaches aiming at tackling this problem can be classified in two main families: protocol driven and information driven techniques. While the former try to minimize the energy spent for radio communication without having any knowledge on the semantic of the information carried by the packet, the latter operate (possibly in a distributed manner) over the actual sensor readings in order to reduce the amount of generated and transmitted data packets. In this context, a sensor selection protocol is an information driven technique that, operating at the application layer, can reduce the number of sensors required to monitor a physical phenomenon without affecting the quality of the data being sensed. Several examples of sensor selection techniques have been proposed ([4],[2]). Most of them makes strong assumptions over the communication protocol (Routing and MAC layer): they assume the communication protocol up and exhibiting several properties such as reliabil-

ity, topology maintenance, clustering,etc ... that in practice are energy wasting. The energy consumption connected to these features is often neglected during the energy performance analysis of the sensor selection protocol. As a result, there exists a trade-off between the energy cost of applying a sensor selection technique and the energy saved using such an approach that is rarely analyzed.

Goals

The exchange period goal was to study cross-layer optimizations between communication layer and sensor selection protocols to maximize the energy awareness of the network. We have developed an energy aware communication protocol based on the Collection Tree Protocol, a well known routing protocol for Wireless Sensor Networks [1] on top of which we implemented the Sensor Selection algorithm Adaptive Random Selection (ARS) [3]. While the former has been developed on Castalia framework for OMNeT++ Simulator[1], the latter has been implemented on MATLAB and integrated with OMNeT++ through a suitable interface.
A technical report of CTP implementation on Castalia will be soon available and we began to study the effects of ARS on our protocol performance (data delivery ratio, power consumption, etc...). Furthermore we are investigating how ARS can tune some routing specific parameters to optimize the energy saving of the network. A paper on this topic is planned to be submitted in the next months.

References

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[1] Castalia is one of most popular frameworks simulating Wireless Sensor Networks in OMNeT++