Medium Access Control in Energy Harvesting - Wireless Sensor Networks

Focusing on Wireless Sensor Networks (WSN) that are powered by energy harvesting, this dissertation focuses on energy-efficient communication links between senders and receivers that are alternating between active and sleeping states of operation. In particular, the focus lies on Medium Access Control (MAC) protocols that are following the receiver-initiated paradigm of asynchronous communication. According to the receiver-initiated paradigm the communication is initiated by the receiver that states its availability to receive data through beacons. The sender is passively listening to the channel until it receives the beacon of interest.

In this context, the dissertation begins with an in-depth survey of all the receiver-initiated MAC protocols and presents their unique optimization features, which deal with several challenges of the link layer such as mitigation of the energy consumption, collision avoidance, provision of Quality of Service (QoS) and security. Focusing on the particular requirements of an energy harvesting application, the dissertation continues with the presentation of a MAC protocol, named ODMAC, which extends the receiver-initiated paradigm with several energy-efficient features that aim to adapt the consumed energy to match the harvested energy, distribute the load with respect to the harvested energy, decrease the overhead of the communication, address the requirements for collision avoidance, prioritize urgent traffic and secure the system against beacon replay attacks.

The performance and behavior of ODMAC and its features are compared to the state-of-the-art and evaluated using mathematical models, simulations and testbed experiments that are based on eZ430-rf2500 wireless development platform. The results validate the efficient use of the harvested energy and demonstrate sustainable operation.

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