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Lifetime vs. Delay in WSN

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Abstract - Increased lifetime and acceptable end-to-end data latency are two basic necessities in large scale applications of wireless sensor networks (WSN) such as environment/habitat monitoring, military surveillance etc. In these applications nodes operate at reduced duty cycles to preserve energy, periodically sense the parameter of interest from the surrounding and reporting it to the base station (sink). Ad-hoc deployment of the sensor nodes and budget constraints are two main hurdles in the fulfillment of these tasks in preferred manner. How we can reduce the energy dissipation from the nodes while maintaining the end-to-end data latency at desired level is the topic of our research.

It has been recognized that with known boundaries of a WSN following advantages can be achieved, routing in WSN can be very efficient, network management tasks becomes very simple and in case of sensor node failures redeployments can be carried out easily. Therefore we start by developing an energy efficient scheme for the boundary identification of a WSN then this information about the boundary is used to propose a data routing protocol that has minimal energy requirements from the sensor nodes as well as acceptable end-to-end data latency.

To accomplish our goals we exploited sink mobility. Introduction of the sink mobility in WSN has shown great advantages in terms of increased lifetime of the network, on the other hand it also results in increased end-to-end data latency due to ever changing routing paths. We proposed the "Mobile sink based boundary identification detection algorithm (MoSBoD)" for a wireless sensor network which neither requires sensor field flooding nor demands equipping each node with any special hardware. As a result, prolonged lifetime of the WSN is achieved compared to state of the art boundary identification schemes without incurring any additional cost. The sink starts by identifying an edge node in the sensor field then the neighboring edge node of the current edge node is determined by the use of RSSI based distance estimation and directional antenna at the sink. Once the neighboring edge node is determined the sink moves to it and repeats the procedure. Thus by moving from one edge node to the next sink identifies all the edge nodes, each of the identified edge node is then connected with its neighboring edge nodes to obtain the boundary of the WSN.

In order to design energy efficient data routing protocol we utilized the information about the boundary of the WSN and proposed congestion avoidance, low latency and energy efficient routing scheme (CaLEe). CaLEe is based on virtual partitioning of the sensor field into sectors. Each sector has a data collector node that is responsible of collecting data from its sector and handing it over to the sink that periodically visits each data collector node. Since each node routes data to its closest data collector node instead of routing directly to sink therefore congestion in the vicinity of the sink can be avoided, length of the routing path from source to sink also gets shortened that leads to increased lifetime of the WSN. Moreover, our simulation results have shown that if small communication ranges of the nodes, low sensor node density or high sensor field throughput is used CaLEe out performs the current state of the art based on static sink or direct routing to mobile sinks both in terms of lifetime of the network and end-to-end data latency.