School of Computer Science

Ph.D. Final Defense
by

TAO ZHENG

ENERGY-EFFICIENT PROTOCOL DESIGN AND ANALYSIS FOR WIRELESS SENSOR NETWORKS

ABSTRACT

Wireless sensor networks are an emerging technology which has the promise of revolutionizing the way of collecting, processing and disseminating information. Due to the small sizes of sensor nodes, resources like battery capacity are very limited. Wireless sensor networks are usually unattended once deployed and it is infeasible to replace batteries. Designing energy-efficient protocols to prolong the network life without compromising too much on the network performance is one of the major challenges being faced by researchers.

Data generation in wireless sensor networks could be bursty due to the presence or absence of events of interest. Therefore sensor nodes stay idle for most of the time. However, idle listening consumes as much energy as receiving. To save the unnecessary energy consumption due to idle listening, sensor nodes are usually put into sleep. We designed an energy-efficient MAC protocol called PMAC in which sleep-awake schedules are determined through pattern exchange. PMAC also adapts to traffic conditions.

To handle bursty traffic and meanwhile preserve energy, dual radio interfaces with different ranges, capacity and power consumption can be employed on each individual sensor node. We designed a distributed routing-layer switch agent which intelligently directs traffic between the dual radios. The low-power radio will be used for light traffic load to preserve energy. The high-power radio is turned on only when the traffic load becomes heavy or the end-to-end delay exceeds a certain threshold. Each radio has its own routing agent so that a better path can be found when the high-power radio is in use.

DMAC is a popular energy-efficient and adaptive MAC protocol specifically designed for gathering data through a tree structure. We have analyzed the impact of the adaptive duty cycle in DMAC on the end-to-end delay and energy consumption for both constant bit rate traffic and stochastic traffic following a Poisson process. The stochastic traffic scenario is modelled as a discrete time Markov chain and expressions for state transition probabilities, the average delay and average energy consumption are developed and are validated numerically. Simulations are carried out with various parameters and the results are in line with the analytical results.

We also proposed a sleep scheme at the routing layer called DGSS which could be incorporated into different data gathering tree formation algorithms. Unlike DMAC, in which nodes are scanned level by level, DGSS starts scanning from the leaf nodes and shrinks inward towards the sink node. Simulation shows that DGSS can achieve better energy efficiency than DMAC at relatively higher data rates.

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Time: 9:30 A.M.

Place: Devon Energy Hall (DEH) Forum room 220

Committee Members:
Dr. Sridhar Radhakrishnan, Chair
Dr. John K. Antonio (CS)
Dr. S. Lakshmivarahan (CS)
Dr. Sudarshan Dhall (CS)
Dr. Suleyman Karabuk (IE)

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