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Two-Hop Routing with Traffic-Differentiation for QoS Guarantee in Wireless Sensor Networks

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This paper proposes a Traffic-Differentiated Two-Hop Routing protocol for Quality of Service (QoS) in Wireless Sensor Networks (WSNs). It targets WSN applications having different types of data traffic with several priorities. The protocol achieves to increase Packet Reception Ratio (PRR) and reduce end-to-end delay while considering multi-queue priority policy, two-hop neighborhood information, link reliability and power efficiency. The protocol is modular and utilizes effective methods for estimating the link metrics. Numerical results show that the proposed protocol is a feasible solution to addresses QoS service differentiation for traffic with different priorities.

Keywords : End-to-end Delay, Packet Reception Ratio (PRR), Quality-of-Service (QoS), Wireless Sensor Networks (WSNs), Traffic-differentiation, Two-hop Neighbors.

1. Introduction

Wireless Sensor Networks (WSNs) form a framework to accumulate and analyze real time data in smart environment applications. WSNs are composed of inexpensive low-powered micro sensing devices called *motes*[1], having limited computational capability, memory size, radio transmission range and energy supply. These sensors are spread in an environment without any predetermined infrastructure and cooperate to accomplish common monitoring tasks which usually involves sensing environmental data. With WSNs, it is possible to assimilate a variety of physical and environmental information in near real time from inaccessible and hostile locations.

WSNs have a set of stringent QoS requirements that include timeliness, high reliability, availability and integrity. Various performance metrics that can be used to justify the quality of service include, packet reception ratio (PRR), defined as the probability of successful delivery should be maximized. The end-to-end delay which is influenced by the queuing delay at the intermediate nodes and the number of hops traversed by the data flows of the session from the source to the receiver. Sensor nodes typically use batteries for energy supply. Hence, energy efficiency and load balancing form important objectives while designing protocols for WSNs. Therefore, providing corresponding traffic differentiated QoS in such scenarios pose a great challenge. Our proposed protocol is motivated primarily by the deficiencies of the previous works (explained in the Section 2) and aims to provide better Quality of Service.

This paper explores the idea of incorporating QoS parameters in making routing decisions the protocol proposes the following features.

1. Data traffic is split into regular traffic with no specific QoS requirement, reliability-responsive traffic; which should be transmitted without loss but can tolerate some delay, delay-responsive traffic; which should be delivered within

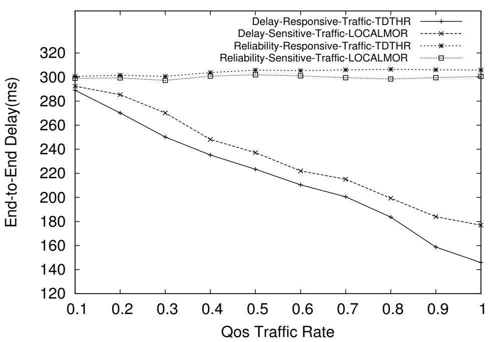

Figure 7. TDTHR vs LOCALMOR - End-to-End delay

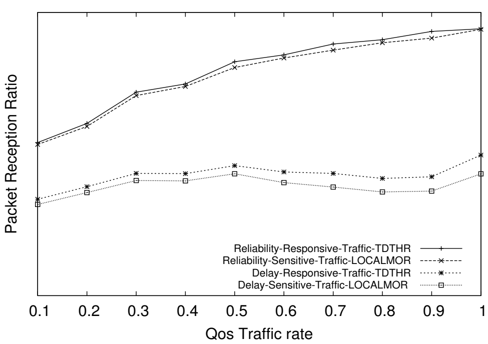

Figure 8. TDTHR vs LOCALMOR - Packet Reception Ratio

among nodes that ensure delivery within the deadline and have high reliability. DARA performs inadequately in terms of energy, as it does neither use any traffic balancing approach nor any probabilistic allocation.

In TDTHR the two-hop based routing will ensure shorter paths between source and sink, by selecting links providing higher PRR on the route to the sink, the energy consumption of the forwarding nodes can be minimized, due to lower number of collisions and re-transmissions and help in traffic balancing. Furthermore, in the proposed protocol the link delay and packet delivery ratios are updated by piggybacking the information in ACK, this will help in reducing the number of feedback packets and hence reduce the total energy consumed. The impact of efficient energy utilization and traffic balancing on network lifetime is depicted in Figure 6, TDTHR and LOCALMOR show good performance compared to DARA and MMSPEED.

Last, we study the performance of TDTHR and LOCALMOR with respect to delay-responsive and reliability-responsive traffic. The QoS traffic is varied in the same way as critical packets were varied in the earlier simulations, *i.e.*, each QoS traffic varies from 0.1 to 1. Figure 7 and Figure 8 examines the results. This comparison is important because we need to ascertain the positive effect of two-hop delay incorporated in TDTHR over the one-hop delay used in the LOCALMOR. The delay-responsive traffic are routed through more delay efficient links, while reliability-responsive traffic, considers only reliable links. From Figure 7 and Figure 8 it is clear that the performance of TDTHR is better than LOCALMOR for delay-responsive traffic due to two-hop information and has similar performance for reliability-responsive traffic.

6. Conclusions

In this paper, we propose a Traffic-Differentiated Two-Hop Routing protocol for quality of service (QoS) in WSNs, it provides a differentiation routing using different quality of service metrics. Data traffic has been sequenced into different classes according to the required QoS, where different routing metrics and techniques are used for each class. The protocol is able to augment real-time delivery by an able integration of multi-queue priority policy, link reliability, two-hop information and dynamic velocity. The protocol is able to increase the PRR, end-to-end delay and improve the energy efficiency throughout the network. This makes the protocol suitable for WSNs with varied traffic, such as medical and vehicular applications.

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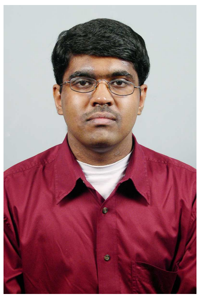

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