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Cross-Layer Design RCH-MAC Protocol for Multihop QoS in Wireless Sensor Networks

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The design of hybrid MAC protocol in Wireless Sensor Networks for delay sensitive data traffic QoS is a challenging work. We present Reservation Control Hybrid MAC (RCH-MAC) protocol for both chain and cross scenarios, which reduces end-to-end delay, energy efficiency and maximizes the packet delivery ratio by minimizing the contention at the nodes. Here, a node operates the reservation procedure at the contention-based period and reserves a time slot in the adaptive contention-free time. All the neighbor nodes of the sender and receiver receives their own reservation control packets. Once reserved, the sender transmits data and receives ACK packets at the adaptive contention-free time. Since reservation packets occur in nodes along the routing path, the nodes reserve time slots successively in multi-hop. Simulation results demonstrate that the proposed protocol has significantly reduced the end-to-end latency and improved other QoS parameters like energy efficiency and packet delivery ratio.

Keywords: Energy efficiency, Hybrid Medium-Access Control (H-MAC), Latency, Reservation Control, Quality of Service (QoS).

1. INTRODUCTION

Wireless Sensor Networks (WSNs) consists of a large number of sensor nodes. A sensor node includes a processor, wireless radio and various sensors. After the initial deployment sensor nodes are responsible for self-organizing an appropriate network infrastructure with multihop connections between sensor nodes. It is used in a wide variety of critical applications such as military, environmental monitoring, industrial process monitoring and health-care units *etc.* Low communication ranges confirm the dense deployment of sensors and only an efficient medium access control (MAC) protocol can handle a number of medium sharing nodes in a better way and form an efficient infrastructure to establish communication links between nodes. In scheduled access, a node can be active only if it is capable of sending or receiving the data. In WSNs, cross-layer design significantly improves energy-efficiency, because WSNs report data wirelessly across multiple hops to a sink node.

The energy is mainly consumed in MAC protocols when the node is just listening and waiting for a packet to be sent. Traffic in WSNs is very low and is triggered by sensing events which is in the form of bursts [1]. Due to this reason, energy consideration has dominated most of the research at MAC layer level in WSNs [2][3]. A long delay is highly undesirable for time-sensitive applications such as critical situation monitoring and security surveillance. For handling real time traffic of event triggering in monitoring based sensor network requires end-to-end latency within acceptable range and the variation of such delay is acceptable [4].

In this paper, we propose a new hybrid MAC protocol called Reservation Control Hybrid-MAC (RCH-MAC) protocol, which is explic-

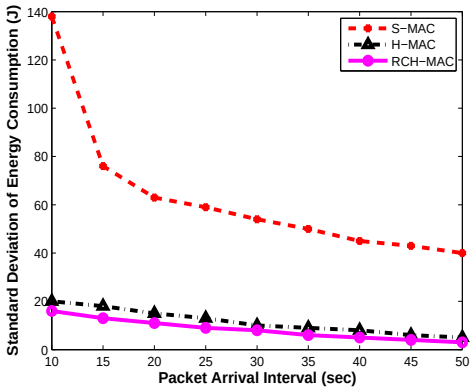

Figure 8. Standard Deviation of Energy Consumption in a 10-hop Cross Scenario

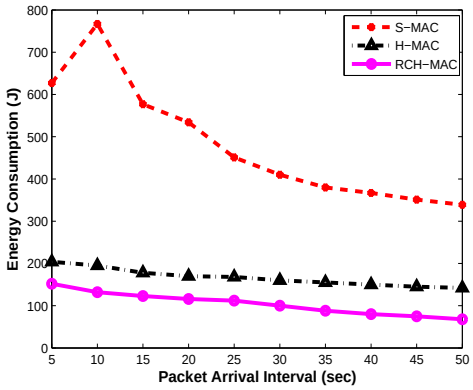

Figure 7. Energy Consumption in a 10-hop Chain Scenario

As shown in Figure 8, it is observed that the nodes remaining energies in RCH-MAC are more evenly distributed than in both S-MAC and H-MAC. Therefore, RCH-MAC is efficient in contention handling, due to the reservation of time slots in adaptive contention-free access time and hence, increases the network lifetime.

7. CONCLUSIONS

In this paper, we have proposed a hybrid RCH-MAC protocol specifically designed for Wireless Sensor Networks. It reduces the end-to-end latency in Wireless Sensor Networks for delay sensitive data traffic QoS support for multihop routing in WSNs. In this case, a node operates the reservation procedure during contention-based period and reserves a time slot in the adaptive contention-free time. All the neighbor nodes of the sender and receiver receives their own reservation control packets. The reservation packets occur in nodes along the routing path. As a result, nodes reserve the time slots successively in multi-hop. Simulation results demonstrate that the proposed protocol has significantly reduced end-to-end latency and improved other QoS parameters like energy efficiency and packet delivery ratio.

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