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Schedule-based multi-channel communication in wireless sensor networks: A complete design and performance evaluation

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ABSTRACT

Recently, wireless sensor networks (WSNs), enabling the connection between the physical world and the digital world, have become an important component of the Internet of Things (IoT). Several applications in the IoT require the efficient and timely collection of larger amounts of data. Due to the interference and contention over the wireless medium, the limited bandwidth of the radios, the limited resources of the battery-operated sensor nodes, this requirement becomes a challenging task. In this research, we exploit the multi-channel operation capability of the radios to provide the higher network throughput and propose an efficient scheduling algorithm to eliminate collision, idle-listening or overhearing, which are consequences of non-coordinated transmissions. Our work focuses on scheduling the regular traffic that is periodically transmitted and on adapting the schedule to the additional traffic that can be requested at some point in time. To deploy the schedule-based multi-channel protocol on real applications, we design the complete communication procedure that is necessary for sensor nodes to communicate among them to form a network and to propagate the sensed data to the collection point. We also propose a low-overhead time synchronization scheme that is critical for a schedule-based protocol. The results of extensive simulation experiments show that the proposed scheduling algorithm can achieve collision-free parallel transmissions over different channels to provide high throughput and high delivery ratio while meeting the crucial energy efficiency requirements. Finally, we demonstrate the feasibility of the protocol and the time synchronization scheme on a laboratory-scaled test-bed of real motes.

1. Introduction

Recently, applications of Internet of Things (IoT), where physical sensors gather data readings from the field and deliver the traffic to the Internet, are emerging rapidly. The data are captured or created by the networks of smart objects or devices equipped with sensors and connected by

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