

Chapter 21

QoS and Energy-Aware Routing for Wireless Sensor Networks

Shanghong Peng

University of Guelph, Canada

Simon X. Yang

University of Guelph, Canada

Stefano Gregori

University of Guelph, Canada

ABSTRACT

Quality of service (QoS) and energy awareness are key requirements for wireless sensor networks (WSNs), which entail considerable challenges due to constraints in network resources, such as energy, memory capacity, computation capability, and maximum data rate. Guaranteeing QoS becomes more and more challenging as the complexity of WSNs increases. This chapter firstly discusses challenges and existing solutions for providing QoS and energy awareness in WSNs. Then, a novel bio-inspired QoS and energy-aware routing algorithm is presented. Based on an ant colony optimization idea, it meets QoS requirements in an energy-aware fashion and, at the same time, balances the node energy utilization to maximize the network lifetime. Extensive simulation results under a variety of scenarios demonstrate the superior performance of the presented algorithm in terms of packet delivery rate, overhead, load balance, and delay, in comparison to a conventional directed diffusion routing algorithm.

INTRODUCTION

Wireless sensor networks represent a new paradigm in wireless technology, drawing significant attention and research from diverse fields of engineering. Many new applications are emerging and the rapid deployment of such networks is underway with busy researchers and engineers creating and

optimizing WSN technology all around the world (Culler, 2003). The vision of many researchers is to create sensor-rich ubiquitous computing and smart environments through planned or ad-hoc deployment of thousands of sensor nodes, each with a short-range wireless communications channel, and capable of detecting ambient conditions, such as temperature, movement, sound, light, or the presence of certain objects.

DOI: 10.4018/978-1-61520-680-3.ch021

The continuous decrease in the size, power dissipation, and cost of sensors has motivated intensive research in the past few years addressing collaboration among sensors in data gathering and processing. Networks of autonomous sensor nodes are having a significant impact on the efficiency of many surveillance and security applications, including environmental monitoring and natural disaster prevention.

However, energy supply is the primary constrained factor in many WSNs powered through batteries or environmental energy sources. To maximize the lifetime of WSNs, it is crucial to develop energy-efficient algorithms that optimize the overall energy consumption. Recently, significant research efforts have been devoted to the power optimization design for WSNs (Heinzelman et al., 2001; Chen, 2008). Since wireless transmission is the dominant power-dissipating operation in WSNs, special cares must be taken to design energy-aware wireless transmission systems.

On the other hand, while much of the existing research in WSNs has been focusing on energy minimization and lifetime maximization, such as in the Low Energy Adaptive Clustering Hierarchy (Heinzelman et al., 2000) and the Power-Efficient Gathering in Sensor Information Systems (Lindsey & Raghavendra, 2002), less efforts were devoted to optimize the quality of service of wireless communication systems. However, in many WSN applications, especially those in surveillance intelligence, data gathering is often required to be timely and reliable (Yu et al., 2004; Tavares et al., 2008; Sohraby et al., 2007). In addition, different applications have different transmission quality requirements on the end-to-end latency, jitter, and packet loss ratio (Aghdasi et al., 2008; Brun et al., 2006; Kumar & Rajesh, 2008; Seo et al., 2007). Some applications may also have dynamic QoS requirements. For example, in object tracking applications, the end-to-end latency requirement is dynamic, since the moving speed of the object is time-varying. Therefore, QoS provisioning is an important issue for WSNs.

Traditionally, the problems of QoS provisioning and power optimization are considered separately at different layers of the OSI (Open Systems Interconnection) reference model (i.e., protocol stack), which is often not efficient in energy utilization. Therefore, a novel adaptive routing algorithm for WSNs is presented, where the QoS requirements and node energy level are jointly designed.

This chapter presents one of the first biologically inspired methods on the joint design of the QoS requirements and energy awareness for WSNs. After providing some background information, a new QoS and Energy-Aware Routing algorithm (QEAR) is described. Next, some simulation results are analyzed in various application scenarios compared with the existing state-of-the-art Directed Diffusion (DD) routing algorithm. Finally, we conclude the chapter with a brief discussion.

BACKGROUND

In a wireless sensor network, groups of sensor nodes need to collaborate together and form a network, which can offer some specific services, such as data collection, environmental surveillance, and target tracking. Consequently, the primary goal for WSNs is to establish one or more routes between two nodes so that they can communicate reliably and efficiently. Such a network is characterized by the following challenges:

- The network topology can change dynamically due to the failure and random movement of nodes;
- Any node may “leave or join” the network (i.e., sleep or active mode) and the protocol must be adaptable accordingly;
- Although no guarantee of service can be provided, the protocol must be able to maximize the reliability of packet in the network for the given conditions.

16 more pages are available in the full version of this document, which may be purchased using the "Add to Cart" button on the publisher's webpage:

www.igi-global.com/chapter/qos-energy-aware-routing-wireless/40768

Related Content

A Source Based On-Demand Data Forwarding Scheme for Wireless Sensor Networks

Martin Brandl, Andreas Kos, Karlheinz Kellner, Christian Mayerhofer, Thomas Posniecek and Christian Fabian (2011). *International Journal of Wireless Networks and Broadband Technologies* (pp. 49-70).

www.irma-international.org/article/source-based-demand-data-forwarding/62087

Synchronous Relaying in Vehicular Ad-hoc Networks

D. Moltchanov, A. Vinel, J. Jakubiak and Y. Koucheryavy (2011). *International Journal of Wireless Networks and Broadband Technologies* (pp. 36-41).

www.irma-international.org/article/synchronous-relaying-vehicular-hoc-networks/55881

A Signal Adaptation Mechanism for Power Optimization of Wireless Adapters

Christos Bouras, Vaggelis Kapoulas, Georgios Kioumourtzis, Kostas Stamos, Nikos Stahopoulos and Nikos Tavoularis (2015). *International Journal of Wireless Networks and Broadband Technologies* (pp. 48-72).

www.irma-international.org/article/a-signal-adaptation-mechanism-for-power-optimization-of-wireless-adapters/154481

Accelerating Biomedical Research through Semantic Web Services

Artemis Chaleplioglou (2016). *Mobile Computing and Wireless Networks: Concepts, Methodologies, Tools, and Applications* (pp. 2199-2214).

www.irma-international.org/chapter/accelerating-biomedical-research-through-semantic-web-services/138375

Student Perceptions and Uses of Wireless Handheld Devices: Implications for Implementing Blended and Mobile Learning in an Australian University

Raj Gururajan, Abdul Hafeez-Baig, P. A. Danaher and Linda De George-Walker (2012). *Wireless Technologies: Concepts, Methodologies, Tools and Applications* (pp. 1323-1338).

www.irma-international.org/chapter/student-perceptions-uses-wireless-handheld/58844