Chapter 4

QoS: Requirements, Design Features, and Challenges on Wireless Sensor Networks

Ricardo H. González G.
Simon Bolivar University, Venezuela

Antonio A.F. Loureiro
Federal University of Minas Gerais, Brazil

Raquel A.F. Mini
Pontifical Catholic University of Minas Gerais, Brazil

ABSTRACT

This chapter presents a survey of the main aspects of QoS that are being used on the Wireless Sensor Networks technology world. We describe approaches based on traditional networks, as well as new approaches that face with resources limitation, which is one of the main characteristics of WSN nodes. This chapter also describes how QoS management creates a series of challenges to deal with, and how some QoS features could be used to enable users to make a better profit of their resource limitations. In our opinion, an exposition of these topics will improve the set of techniques and strategies that designers and programmers could use to develop and implement satisfactory services level to their applications in WSNs.

INTRODUCTION

WSNs are a class of wireless ad hoc networks that are different from conventional networks (Heinzelman et al., 1999) by several reasons: its small footprint, its low cost design, and its nodes scarce resources such as: limited supply of energy, limited storing and computation power, low bandwidth and energy-conserving communication. These limitations prevent them from running sophisticated network protocols, and limit inter-nodes communication. However WSNs technology also offers a series of features described as advantages by Krishnamurthy et al. (2005), Shen et al. (2004), and Paavola (2007), where can be highlighted: the ability to capture online information directly from field devices, the reduction of deployment and maintenance costs, compared to wired connection infrastructure on heavy duty or isolated environments, the improvement on area visibility due to...
the lack of wires, enabling a better visualization of devices, and the decentralization of monitoring and automation functions. All these features can be used to improve the collection of information from the real world.

In WSNs there are different types of roles that each node could play: the Sensor Node (SN) role, which covers activities related to the capture of information from the real physical world (sensed data), the Routing Node (RN) role, that deals with the relay of sensed and management data from SNs to the Sink, and finally the Sink role that gathers any collected information from the whole network or the one that comes from only a subset of network nodes. The Sink behaves as a portal or link between the user of the applications and the wireless sensor nodes. Some nodes in the network could play more than a role at a time and, in fact, it is very common that many nodes play both the SN and the RN roles.

Due to the fact that WSNs have to interact directly with their environment to collect data, some of their characteristics are expected to be very different from other more conventional data networks. This differentiation implies a series of challenges that WSNs have to face, and that was described by Chen and Varshney (2004), Younis et al. (2004) and Wang et al. (2006). These topics include features such as: severe resource constraints, unbalanced traffic, data redundancy, network dynamics, energy balance, scalability, multiple sinks, multiple traffic types, information about packet relevance, energy and delay trade-off, etc.

Meanwhile, some of the main QoS goals in conventional wireless networks are to provide high throughput, low delay or high bandwidth efficiency. For a sensor network, one of the main concerns is to enlarge the network lifetime. To reach this QoS goal, network designers must save energy, probably giving up performance in other aspects of the operation such as delay and bandwidth utilization. This occurs because each node depends on limited power energy sources, such as batteries, that could not be enough to cover node energy expenses for long periods of time, especially when they are operating in hostile or remote regions, where they cannot expect replacement (Bhatnagar et al., 2001).

This chapter comprises an introduction to general characteristics of QoS on WSNs. Its first Section presents a description of the QoS requirements that could be defined on WSNs. The second Section describes some strategies and techniques that could be used to reach some requirements in WSNs, including a survey of some projects that manage some QoS features. The third Section presents some challenges and open research topics about dealing with QoS on WSNs. Finally, the last Section describes some conclusions about present and future of QoS on WSNs.

**QOS REQUIREMENTS IN WSNs**

QoS can be defined as the collective effect of service performance which determines the degree of satisfaction of a user of the service (ITU-T, 1994). Different applications require different QoS and if they do not meet the requirements, the resulting behavior will be unsatisfactory (Chen & Varshney, 2004).

When a wireless system has to work with QoS, it can offer two different alternatives: Soft or Hard QoS. Soft QoS means that there could exist time periods when the required QoS is not guaranteed due to path breaking or network partition (Chen & Nahrstedt, 1999). This situation is also called a best-effort service. On the other hand, if a Hard QoS (Lutfiyya et al., 2001) is offered, then there is a guarantee that resources will be available when they are required. This Hard QoS should be guaranteed by statically allocating resources based on worst-case scenario. Hard QoS is important in systems that must meet their timing constraints to avoid disastrous consequences, but it is very difficult to reach in wireless systems where it is hard to manage a reliable delivery mechanism on the air interfaces.
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