IRM PRESS
701 E. Chocolate Avenue, Suite 200, Hershey PA 17033-1240, USA
Tel: 717/533-8845; Fax 717/533-8661; URL-http://www.irm-press.com
ITB10714

Chapter IX

Wireless Sensor Networks

Erdal Cayirci, Istanbul Technical University, Turkey

Abstract

A wireless sensor network is deployed either inside the phenomenon or very close to it. Unlike some existing sensing techniques, the position of sensor network nodes need not be engineered or predetermined. This allows random deployment in inaccessible terrains. On the other hand, this also means that sensor network protocols and algorithms must possess self-organizing capabilities. Another unique feature of sensor networks is the cooperative effort of sensor nodes. Sensor network nodes are fitted with an onboard processor. Instead of sending the raw data to the nodes responsible for the fusion, sensor network nodes use their processing abilities to locally carry out simple computations and transmit only the required and partially processed data. Realization of sensor networks requires wireless ad hoc networking techniques. In this chapter, we present a survey of protocols and algorithms proposed thus far for wireless sensor networks. Our aim is to provide a better understanding of the current research issues in this field. We also attempt an investigation into understanding design constraints and outline the use of certain tools to meet the design objectives.

Introduction

Advances in digital electronics, embedded systems, and wireless communications led the way to a new class of ad hoc networks, namely, wireless sensor networks (WSNs), that consist of sheer numbers of tiny nodes randomly deployed either inside the phenomenon or very close to it. Sensor network nodes are fitted with an onboard processor, and they can collaborate both in sensing and transferring the sensed data. WSNs have a wide range of potential applications, including security and surveillance, control, actuation and maintenance of complex systems, and fine-grain monitoring of indoor and outdoor environments. Some examples for these applications are explained below.

- **Military Applications:** WSNs can be an integral part of military command, control, communications, computers, intelligence, surveillance, reconnaissance, and targeting (C4ISRT) systems. The rapid deployment, self-organization, and fault-tolerance characteristics of sensor networks make them a very promising sensing technique for military C4ISRT. Since sensor networks are based on the dense deployment of disposable and low-cost sensor nodes, destruction of some nodes by hostile actions does not affect a military operation as much as the destruction of a traditional sensor. Some of the military applications are monitoring friendly forces, equipment, and ammunition; battlefield surveillance; reconnaissance of opposing forces and terrain; targeting; battle damage assessment; and nuclear, biological, and chemical attack detection and reconnaissance.
- **Environmental Applications:** Some environmental applications of sensor networks include tracking the movements of species, that is, habitat monitoring, monitoring environmental conditions that affect crops and livestock, irrigation, macro instruments for large-scale Earth monitoring and planetary exploration, and chemical and biological detection.
- **Commercial Applications:** The sensor networks are also applied in many commercial applications. Some of them are building virtual keyboards, managing inventory control, monitoring product quality, constructing smart office spaces, and environmental control in office buildings.

Sensor networks differ from conventional network systems in many aspects. WSNs usually involve a large number of spatially distributed, energy-constrained, self-configuring, and self-aware nodes. Furthermore, they tend to be autonomous and require a high degree of cooperation and adaptation to perform the desired coordinated tasks and networking functionalities. As such, they bring about new challenges and design considerations, which go much beyond conventional network systems. These design considerations, which are the reasons to develop new schemes and technologies rather than using available ad hoc networking technologies, can be summarized as follows (Akyildiz, Su, Sankarasubramaniam, & Cayirci, 2002).

- **Topology:** In WSNs, 100s to several 1,000s of sensor nodes (snodes) are densely deployed throughout the sensor field. The distance between two neighboring