1. Introduction

A wireless sensor network is a collection of wireless sensors called motes that form a certain network topology. Sensor nodes are densely deployed inside the phenomenon (or very close to it) we want to analyze and are have the capabilities to collect data through some physical sensor put on them.

Sensor data is collected from the observed area, locally processed or aggregated, and transmitted to one or more basestations.

A sensor node combines the abilities to compute, communicate, and sense. So a sensor node consists in a processing unit, communication module (radio interface), sensing and actuator device.

Wireless microsensor networks promise novel applications in several domains.

Forest fire detection, battlefield surveillance, or telemonitoring of human physiological data are only in the vanguard of plenty of improvements encouraged by the deployment of microsensor networks.

Sensor nodes can be spread out in dangerous or remote environments whereby new application fields can be opened.

Wireless sensor networks enable the monitoring of a variety of possibly inhospitable environments that include home security, machine-failure diagnostic, chemical/biological detection, medical and wild habitat monitoring. These applications require reliable, accurate, fault-tolerant and possibly real-time monitoring. Meanwhile, the low energy and processing capabilities of the nodes require efficient and energy-aware operations.

Generally, when people consider wireless devices they think of items such as cell phones, personal digital assistants (PDA), or laptops with 802.11. These items cost hundreds of dollars, target general purpose applications. In contrast, wireless sensor networks use small, low-cost embedded devices for a wide range of applications and do not rely on any pre-existing infrastructure. The vision is that these devices will cost less that $1 by 2006.

Each sensor node delivers the collected data to one (or more) neighbor node, one hop away. By following a multi-hop communication paradigm data are routed to the sink and through this to the users. Therefore, multi-hop ad hoc techniques constitute the basis also for wireless sensor networks. However, the special constraints imposed by the unique characteristics of sensing devices, and by the application requirements, make solutions designed for multi-hop wireless networks generally not suitable for sensor networks [Aky02]. Research activities on sensor networks have mainly focused on networking protocols [Aky02, Int00, San03, Wan02, Wan03], topology control [Xu03], time synchronization [Els01], data management [Rat02, Mad02], security, etc. Special attention has been devoted to study energy-efficient solutions [Rag02] (energy is a very critical factors in sensor networks since individual sensor nodes have a non-renewable power supply and, once deployed, must work unattended). Most of these proposals have been evaluated validated through extensive simulation analysis [San03, Wan02, Wan03, Int00]. Generally, these simulation studies are based on the ns-2 tool and assumes the IEEE 802.11 CSMA/CA protocol to characterize the physical and data link layers. One may argue whether this modeling provides an accurate characterization of a real sensor network. The aim of this thesis is to exploit measurements on a real testbed to answer the above question. To this end hereafter we will investigate whether the IEEE 802.11 model provides an adequate characterization of sensor networks lower layers. If this is true we wish to investigate the correct model parameter setting. Specifically, we intend to investigate the main elements that characterize the sensor network performance, e.g., impact of weather conditions on the transmission range, energy consumption in different conditions, etc. In this work we present the results of an extensive measurement campaign. Specifically we used mica2 and mica2dot Berkeley motes and considered different scenarios and traffic conditions. To investigate the impact of environmental conditions on the performance sensor nodes the experiments were done in an outdoor environment under various atmospheric conditions. Though the analysis is related to a specific technology (i.e., Berkeley motes) we think that the results obtained still provides general useful information. Specifically, we found that the atmospheric environment (e.g., fog or rain) may have a severe impact of the transmission range of sensor nodes. This is very important since sensor networks are expected to work in changing atmospheric conditions. Furthermore, based on our experimental results we derived a channel model for the CSMA/CA-based MAC (Medium Access Control) protocol used in our sensor devices. We found that this channel model is very similar to the IEEE 802.11 channel model [Ana04]. Our findings prove that, modeling the lower layer of a sensor network as an IEEE 802.11 network can be considered acceptable as far as the channel model.

The work is organized as follows.
Chapter 2 briefly describes Sensor Networks.
C*hapter 3* introduces the Berkeley motes technology.
Then in *Chapter 4* we investigate about performance indices through several experimental tests that have led to a sensor network system model (*Chapter 5*).
Finally other tests are reported in the appendix (*Chapter 7*).