Chapter 6
A Modeling Approach to Building Wireless Sensors

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ABSTRACT

The gap between wireless sensor networks and application experts such as doctors, physicists, and biologists is slowly closing. Previous efforts have been made to bring the two together, but a design and implementation methodology for the lone user has never been proposed. In this chapter, a procedure is proposed based on the author's experience building and programming a wireless humidity sensor for a greenhouse with only a small amount of previous programming experience. Various factors affecting the design and construction of sensor nodes are analysed and then applied in a practical manner in the project. The project ended prematurely due to hardware faults but reached a point that allows the continuation of the methodology in a theoretical fashion.

1. INTRODUCTION

For some years now, data collection methodology has been slowly changing. Whereas years ago wired sensors were the standard, thanks to the developments in the field of Micro-Electro-Mechanical Systems (MEMS), it is now possible to build low power, low cost, wireless sensor nodes("motes" in North America) capable of a variety of functions. The typical structure of a wireless sensor is shown in Figure 1.

Although already employed for decades in a wide range of applications, the older generation of wireless sensors were expensive, difficult to build and required lots of maintenance. Advancements in software and hardware technology have allowed for a new generation of reliable sensor networks to be developed.

The software for modern sensor node networks can be traced to projects such as the ongoing NASA Sensor Webs Project (Strivastava, 2001) and the Smartdust project of 1998 (Pister, Kahn,

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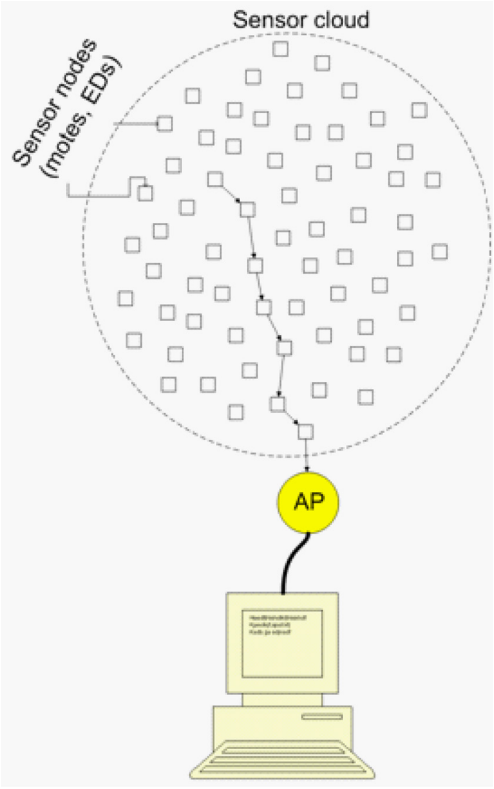
Figure 1. A multi-hop wireless sensor network



& Boser, n.d.). Hardware advancements came from such projects too, but also from research done by semiconductor and computer technology companies.

The most immediate advantages of wireless over wired sensor nodes are that they are less intrusive in the environment, easier to place, and potentially cheaper. Since motes have on-board processors, they can form a network and so are able to:

- Communicate with relays that return the relevant data to a base-station.
- Communicate with each other so possess self-organizing capabilities.

Therefore, a large quantity of them can be deployed around the sample without requiring pre-determined location engineering. It also means that they can be placed in hazardous or hard-to-reach locations like disaster areas. Another important advantage of wireless sensor nodes is that, thanks to their processors, they are able to transmit both raw and partially processed data by carrying out simple computations locally.

The features mentioned previously allow for a wide range of applications such as healthcare, military, and security. By using wireless sensing, a doctor could monitor the condition of a patient less intrusively and at the same time better understand his or her ailment. Military use of wireless sensors can range from reconnaissance to data collection in battle environments. Security applications could include protecting a house by placing sensors around the perimeter of the property. Unlike standard sensors and cameras, since motes do not need wires, they are much easier to place so can be set up in hard to reach locations. With the right sensors, motes are also potentially able to detect the presence, location, and concentration of foreign agents in air and water, giving valuable insights into the status of the ozone layer or the quantity of greenhouse gases in the atmosphere.

One big problem is that there are few established standards in the field of wireless sensors, although they are becoming more prevalent as time passes. Texas Instruments and other companies have already complied with technologies such as ZigBee, which is "a standards-based technology for remote monitoring, control and sensor network applications" (Texas Instruments, 2011), which allows enough functionality to, for example, create security networks.

These technologies and the lack of established standards can be confusing to non-experienced users so implementation experts are often called in to help the users, which can cause more confusion, slowdowns and increase the costs. Communication between the application expert and the implementation expert is paramount, yet there will always be a modicum of guesswork on both sides as neither exactly understands the other's requirements and limitations. This paper