Energy Efficiency of the Wireless Sensor Network

Introduction

Improvements in the wireless network technology have made sensors in the network smaller in size while remaining simple to implement; as a result, the wireless sensor network are incorporated into majority of the electronics in the modern society. Its potential for wide range of application has made the energy efficient wireless sensor network increasingly important for application such that there is difficulty supplying sufficient power to the sensors in the network. This paper focuses on such a wireless sensor network which puts its emphasis on the energy efficiency as well as its real world applications, technologies that improve its energy efficiency, and how the network can be implemented.

Real World Applications

The energy-efficient wireless sensor network is especially significant when it is applied to the condition where there is limited energy available or no guarantee for the constant power supply. In these conditions, the energy efficiency of the network is crucial to enhance the lifetime of the network. Especially when sensors are battery-free, the network becomes virtually self-sustainable. Honeywell is integrating such sensors in their gas detection systems underground [1]. The use of sensors for gas detection is under research for further improvements, and engineers of Massachusetts Institute of Technology’s Microsystems Technology Laboratories are developing sensors that are further reduced in size to enable them to be the real-world solution for hazardous chemical detection [2].

Underlying Technology

The result of the energy efficiency of the wireless sensor network is not only the reduction in the power consumption of the network; it also enhances its lifetime. Despite of the increase in the complexity of the technology to achieve the energy efficiency, however, a sensor has to remain simple, be able to achieve a certain fault tolerance level, and be low in the bandwidth occupation.

Energy-Efficient Sensors

A typical sensor has two distinctive phases: low workload and high workload. During the low workload phase, a sensor constantly wakes up to sample data and goes back to a sleep mode. In this phase, it is necessary to implement a rapid wakeup capability and low power sleep mode to improve the energy efficiency. The high workload phase consists of significant amount
of computation and communication with other nodes; in order for this phase to be energy efficient, a sensor has to perform these tasks with relatively low in power. It is impossible to simultaneously attain energy efficiency in two phases because of their relationships, and one way to improve overall energy efficiency is to incorporate two different kinds of processors. For example, the processor of Crossbow Mica2 provides quick wakeup capability while Intel Stargate can execute calculations during a high workload with more energy-efficient manner; when these two are combined, overall energy efficiency of the sensor increases [3].

**Energy-Aware Routing**

The network transfers data from a source to a destination using a routing algorithm. There are two basic functions for the routing, and they are determination of the optimal routing paths and actual transportation of the data [4]. Optimal path is determined based on different aspects, such as distance and bandwidth, depending on the routing algorithm, and an energy-aware routing decides its optimal path based on the residual energy of sensors in the network. The effect is the increase in the energy efficiency of the network. Low-Energy Adaptive Clustering Hierarchy (LEACH), for example, divides the network into several clusters, and the local base station of the cluster randomly rotates to evenly distributes energy loads among the sensors. The result of this method is doubled lifetime of the network than one without energy-aware routing algorithm [5]. Geographic Routing with Environmental Energy Supply (GREES) protocol is another example which bases its decision of the routing on the residual energy level of neighboring nodes (sensors) as well as energy supply of the environment [6].

**Implementation**

The routing occurs at Layer 3 (the network layer) of the sensor [4] and can be easily implemented or altered by coding. The Crossbow Mica2 and MicaZ are equipped with the modules of IEEE 802.15.4 and ZigBee standards; the module can be customized with a programming language called tinyOS [7], [8], the open-source operating system well suited for embedded wireless sensor networks [9]. IEEE 802.15.4 is the standard that especially for energy-efficient yet simple wireless sensors [10], and the GreenPeak Lime CM-08, ultra-low power sensor with energy harvesting capability, also follows this standard as well as ZigBee standard [11].
Bibliography


