

Stony Brook University The Graduate School

Doctoral Defense Announcement

Abstract

The Cayley Graph Implementation in TinyOS for Dense, Self-organized, Energy-efficient Wireless Sensor Networks

By

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Recent dramatic development in micro-electronic-mechanical systems (MEMS), wireless communications and digital electronics have lead researchers and industry manufacturers to develop small size, low-power, low-cost sensor devices. Such devices can integrate data processing, communications and sensing capabilities. A wireless sensor network (WSN) of the type investigated here refers to a group of sensors, or nodes, linked by a wireless medium to perform distributed sensing tasks. Connections between nodes may be formed using infrared devices or radio frequencies. Wireless sensor networks will be used for such tasks as surveillance, widespread environmental sampling, security, and health monitoring. Much of the research in sensor networks is funded for military tasks, but applications such as forest fire detection and rush-hour traffic monitoring exemplify the versatility envisioned for this rapidly expanding technology. Many successful sensor applications have been deployed in very specialized networks, such as

UCBerkeley's Smart Dust [1], MIT's ¹-Adaptive Multidomain Power aware Sensors [2], and UCLA's Wireless Integrated Sensor Networks [3]. Wireless Sensor Networks can contain hundreds or thousands of sensing nodes. It is desirable to make these nodes as cheap and energy-efficient as possible and rely on their large numbers to obtain high quality results. Due to the Wireless sensor network's properties of low-energy-efficiency, large-scale, low cost and lossy nature, new network protocols must be developed to achieve fault tolerance while minimizing energy consumption. Wireless channel bandwidth must be shared among all the sensors in the network, routing protocols for these networks should be able to perform local collaboration to reduce bandwidth requirements. Also, developing sensor network applications demands a new set of tools to aid programmers.

The dynamic and lossy nature of wireless communication poses major challenges for highly dense WSN. This research first surveyed the protocols and simulators for WSN, implemented in commercial systems, such as Reliable-Route in Xbow; then developed application program for a project called "Sleep Apnea" based on Xbow sensor network product; finally, based on the Cayley Pseudo-Random Protocol [4, 5, 6, 7] for large wireless sensor networks, we proposed the Cayley Graph's networking topology in Xbow's [8] WSN and implemented the Cayley Graph on Crossbow Technology Inc's sensor nodes [8]. The Cayley Graph topology is implemented via the TinyOS emulator, Power Tossim [9]. The performance of the network is evaluated in terms of energy consumption, network lifetime and fairness. Comparison is made with the Xmesh protocol and showed that our Cayley Graph Implementation consumes less power but trade off with fairness in a relatively small amount.

Date: August 8th, 2007

Time: 2:00pm

Place: 250 Light Engr.

Program: Ph.D, ECE

Dissertation Advisor: K. Wendy Tang