

# Project Proposal for Candice

## **SUPERB Summer 2003**

The PicoRadio project is a research effort exploring dense networks of very small low-power embedded System-On-Chip (SOC) devices. These devices communicate with each other via radio links. The application space for PicoRadio includes numerous types of sensor networks and anything else that requires large numbers of inexpensive devices producing relatively low-bandwidth data in a decentralized way.

One “sub-project” within PicoRadio is to design a prototype sensor node and the wireless network in which it will operate. This project will utilize our advanced low-power radio front-end (the analog part) in combination with some technologies under development at HP Labs. Each node will conduct a brief dialog with other nodes when it’s close enough for communication, where information such as ID, node status, and attributes are exchanged. There are many applications for this type of information, such as inventory control and finding your lost keys.

There are three major parts to this network: 1) the hardware node, which will include a small microcontroller, a Field Programmable Gate Array (FPGA), the radio, power supplies, and other miscellaneous stuff, 2) protocols that govern the dialog between nodes e.g. when is it OK to transmit, how is data encoded in a packet, what to do with received packets, etc, and 3) the application that makes use of the collected data.

A core goal of this network is low-power operation. The hardware nodes will be prototypes using commercial off-the-shelf (COTS) hardware except for the radio, so power consumption will be somewhat higher than a PicoRadio SOC chip in the same application but we will be able to forecast real power numbers based on experiments with the prototypes. The protocols, however, will be custom designed and will be the same protocols that run in a fully custom node.

There will be four people on this team: a BWRC technical staff member, a representative from HP Labs, a UCB undergrad doing a summer internship, and you. Professor Jan Rabaey will supervise the team. Hardware and protocol design will be a group effort but the students, in close cooperation with the staff member, will do most of the implementation. Implementation in this case means building and testing the board, and writing and testing the protocol suite. Application design will most likely be done at HP Labs.

Since SUPERB is a relatively short program the best option for a project would be the protocols, unless you have a strong interest in hardware design. In this system, protocols will be implemented largely in software so design cycle times will be relatively short.

For more info on PicoRadio, see <http://bwrc.eecs.berkeley.edu> and click on the PicoRadio link. Also, you can get some idea of what SUPERB students have done at BWRC in the past at [http://bwrc.eecs.berkeley.edu/Research/Pico\\_Radio/SUPERB.htm](http://bwrc.eecs.berkeley.edu/Research/Pico_Radio/SUPERB.htm). For info on Jan, see <http://bwrc.eecs.berkeley.edu/People/Faculty/jan/>

## **Project Outline:**

This project will be to develop a set of communication protocols for a simple sensor network, then implement and test them. You'll have access to a lot of help in all of these areas (particularly development) and you will be working as a member of a team, but the implementation and test portion of the task will be tailored as a one person job. There will probably be quite a bit of brand-new and complex stuff that you'll be exposed to, but you will have access to whatever help you need.

### **It will follow these steps, more-or-less:**

1. Learn about the PicoRadio project and sensor networks in general
2. Gain a basic understanding of network protocols, with emphasis on low power.
3. With the team, develop the protocols needed for the prototype network.
4. Implement the protocols, initially on the existing PicoRadio Test Bed.
5. Test the protocols.
6. Run experiments using several nodes here at the BWRC, and take measurements of network performance.
7. Port (modify) the implementation to the new hardware, if available.

### **What you will learn, among other things:**

1. How a sensor network operates.
2. Designing for low-power systems.
3. An overview of communication protocols, and detailed understanding of a representative sensor network protocol.
4. How to write code for embedded systems.