New Software and Hardware Tools for Teaching Low-Power Wireless Communications

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Experts say that embedded systems are "everywhere" around us. Embedded Systems Development is the field of putting small computers in everyday items, like microwave ovens and wireless phones. Wireless communications has become an important commercial product feature and research topic within the last ten years. There are now more mobile phone subscriptions than wired-line subscriptions. One area of commercial interest lately has been low-cost, low-power, and short distance wireless communications used for "personal wireless networks." Specifically, Bluetooth components have been included in mobile phones, head sets, Personal Digital Assistants (PDA), PCs, printers, and other devices. A new communications standard, IEEE 802.15.4, has been created to further reduce the power requirements and cost of devices.

With new technologies and devices come new business activity, and the need for employees in these technological areas. Engineers who have knowledge of embedded systems and wireless communications will be in high demand. Unfortunately, there are few affordable development environments available for classroom use, so students often do not learn about these technologies during hands-on lab exercises.

The goal of a development and teaching effort was to create a low-power embedded system which could be used to teach wireless communications hardware and protocols. The specifications of these new teaching tools were that:

- The base embedded microcontroller environment should be a very low cost off-the-shelf development board. Two were selected: the Renesas M30262 SKP board ($40) and the Atmel AVR Butterfly board ($20). These two boards have accompanying development software and compilers.
- The communications electronics should be low cost Bluetooth and 802.14.5 devices which are attached to the development board via removable daughter boards.
- Basic communications protocols should be implemented to allow the boards to work and communicate, as identified by the standards specification. The use of these basic protocol software libraries were documented so that students, with the correct development board and communications daughterboard, could use this software.
- The basic protocols and daughter boards should be used by students in an embedded systems or computer interfacing course.

This paper presents the results of the development effort and experiences in using these hardware and software tools in the classroom. Specific assessment of student skills that were needed as a prerequisite and successes based on prerequisites will also be addressed.