NJIT

IEEE North Jersey Communications Chapter

Pico radios - what does it take to design a link between them?

by Lizhi Charlie Zhong, UC Berkeley

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About the Speaker

Lizhi Charlie Zhong (B.S.E.E. 93, M.S.E.E. 95) is a Ph.D. candidate in electrical engineering and computer science at the University of California at Berkeley. His dissertation is on the analysis and design of energy-aware data-link layer for wireless sensor networks. From June 2002 to present, he is with STMicroelectronics Central R&D Berkeley Research Laboratory. He is currently developing a MAC proposal to be submitted to the IEEE802.11n task group by June 2004. His research at ST also includes the MAC design for cognitive radios. From January 1995 to August 1998, he was with the AT&T Bell Laboratories. His research interests were in the area of digital wireless communications systems. Mr. Zhong has three technical patents on CDMA. He also received two awards from the Bell Laboratories in 1996, including a Most Valuable Player (MVP) Award for extraordinary achievements on the CDMA program.

About the Talk

Wireless sensor networks change the way we live: in building environment, these tiny radios can work together to create a personalized micro-climate; in home health care, a doctor can monitor the health of his patients attributed to the networks of medical sensors in their homes; sensor networks can also be used to control traffic, mitigate disaster as well as improve the efficiency of the energy-generation, distribution, and consumption infrastructure.

To these pico radios, the power consumption is crucial. It might be OK to charge your cell phone every day, but it would be a nightmare to replace the batteries of hundreds of pico radios every day or even every month. If the power consumption of such a radio can be kept sufficiently low (e.g., < 100uW), power obtained through energy scavenging techniques will be enough to keep it self-powered. The outcome is very exciting: maintenance will be much easier and the network operation will be more robust, free from the impact of dead nodes. However, it is no easy task to bring the overall power consumption down to such a low level. Designers of sensor networks have attempted to optimize the power consumption of a component of a system in an isolated fashion, only to find that when the power consumption of a component is pushing down, the power consumption of another component goes up. It has become evident to the designers that how the overall power consumption depends on the design parameters of the components is the most important question in power-aware designs.

In this talk, a two-step approach to the above problem will be presented. In the first step, a system is divided into smaller subsystems based on functionality. For each component, an analytical model is developed. In the second step, the models of different components are integrated. This integration (often ignored by other designers) is essential to the disclosure of the overall power consumption's dependency on the design parameters. In this integration process, an interface is first defined for every model, after which the interactions between the components are modeled with mathematical equations. The existence of the closed feedback loops makes the integration much harder. I will show that they can be solved using the fixed point theorems and an "optimization after integration" technique.

We can use the insights gained from the above modeling framework to obtain guidelines for power-efficient designs. In fact, the guidelines from our analysis have already had a real impact on the design of an actual sensor network. For examples, the speaker will introduce several emerging designs developed in the Berkeley Wireless Research Center, including a channel hopping scheme and an adaptive sleep discipline.

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