

Networking Research for the Wireless Body Area Network

Motivation

We envision a smart wireless body area network (BAN) which comprises a number of intelligent low-power devices that include biomedical sensors and storage devices. The BAN is worn on the human body to sense, monitor and store vital biomedical signals and data in support of medical and/or sports applications. The BAN interconnects to the external world through a gateway, e.g., a PDA or mobile phone equipped with WiFi and/or GPRS/3G technologies.



Fig. 1. Example of BAN Device

Objective

The aim of our group is to design and develop a body area network (BAN) platform for healthcare and other related applications. Specifically, we are concerned with the various networking aspects of the BAN platform which are described below.

Scope

Our project has two main thrusts – (i) Architecture & power efficient protocol stack and (ii) Real-time operating system.

Architecture & Power Efficient Protocol Stack

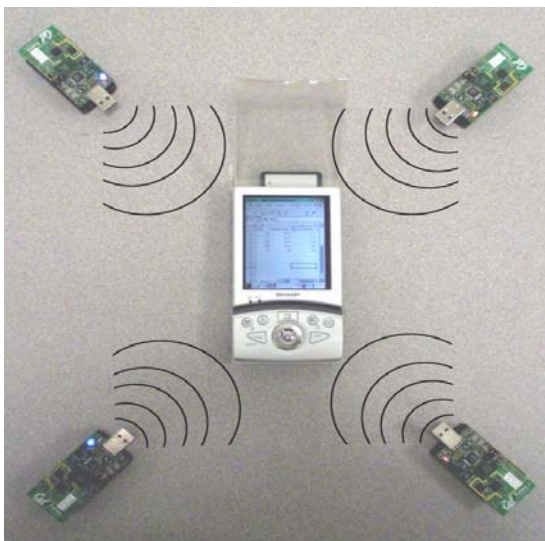


Fig. 2. Star Architecture for the BAN

The performance of the BAN will depend on the way in which the devices in the BAN are interconnected. We have two architectural modes: star and multihop. The star architecture offers simplicity and scalability and allows the gateway to coordinate medium access control, mitigating the energy loss due to collisions (see Fig. 2). In multihop, sensors communicate with both the gateway and other sensors. The advantage of multihop is flexibility and convenience. In addition, nodes need much smaller transmission power since they need not transmit to the gateway directly.

The components of the protocol stack will have to be designed so that performance requirements are met despite the severe computing capabilities of the sensing devices.

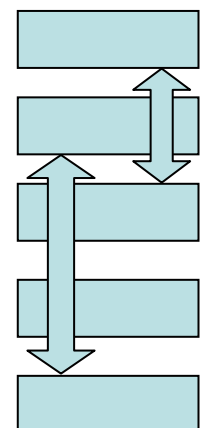


Fig. 3. Cross-layer Interactions

Furthermore, the limited energy resources of the sensing devices require careful design of the protocols used. Finally, the dynamic nature of the wireless channel poses further challenges to the design problem. These observations mean that existing protocols for communication networks cannot be used directly and that new protocols (e.g., MAC) need to be designed. We are currently looking at the design and performance of efficient MAC protocols. We are also investigating the feasibility of cross-layer optimization in the protocol stack (see Fig. 3).

Real-time Operating System

One of the main challenges we have identified is the design and development of a real-time operating system (RTOS) for the BAN platform. The RTOS will have to be chosen with the processing and

storage limitations of the wireless devices in mind. These limitations along with our application constraints make it difficult to reuse existing off-the-shelf operating systems. We are evaluating the feasibility of existing sensor operating systems such as TinyOS.

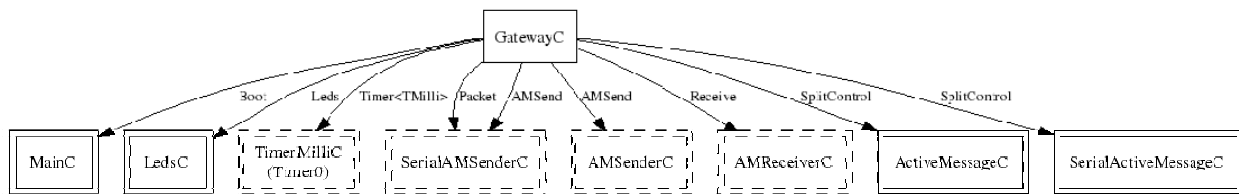


Fig. 4. TinyOS Interface Specification for the Gateway Application

Innovative Ideas

Our main focus is on networking in the context of the wireless body area network. The fact that the network now resides on the human body adds more challenges to the already difficult problem of ad-hoc networking. We see this as an opportunity to innovate and build networks and applications that can improve the quality of life for all of us.

Demonstrable Activities

We will evaluate real-time operating systems, network architecture, and MAC protocols in the context of a wireless body area network. With respect to these three issues, we will modify existing RTOS to meet the needs of the BAN project. We will demonstrate the feasibility of the BAN architecture. We will also design new MAC protocols and verify their efficiency via simulation and implementation in the BAN.

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