

## Chapter 4.10

# An Advanced and Secure Symbian–Based Mobile Approach for Body Sensor Networks Interaction

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### **ABSTRACT**

*The combination of body sensor networks (BSNs) and mobile devices brings a personalized health monitoring opportunity to patients and medical teams. Mobile devices may be used to process and present data collected by BSN sensors in an easy and meaningful way to users. The mobility of such systems improves patients' quality of life, enabling continuous unobtrusive health monitoring during regular daily routine tasks. This paper presents a Symbian-powered smartphone based solution for BSN sensors data gathering, monitoring, and presentation. The systems' sensor platform hardware provides an onboard long-term data storage module, enabling continuous data gathering even in the absence of the mobile device. The mobile device connects wirelessly to the BSN using Bluetooth technology, supporting interaction with multiple sinks. This system aims to help patients that need continuous monitoring of human bio-physiological parameters in a transparent and unobtrusive way. A case study is presented, based on a sensor for women's core body temperature collection, enabling fertility follow up processing. The system was evaluated successfully, proving its usefulness in a real scenario. As a result, it is ready for regular use.*

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## **INTRODUCTION**

The advantages of using body sensor networks (BSNs) in medical and health areas have drawn much interest over the last years. The continuous evolution of sensor and network technology, increase the number of applications where they can be used, mostly to monitor physiological and biological parameters in a single human body (Fowler, 2009a; Fowler, 2009b; Laerhoven et al., 2004; Pantelopoulos & Bourbakis, 2008). Medical staff can use data gathered by BSNs for monitoring and control of several diseases or human body phenomena (Nebeker, 2002). However, in certain scenarios, patients require control and monitoring of their own parameters in their regular daily life, enabling early detection of health abnormalities. Thus, BSN-based systems increase the quality of life of the patients, which not require continuous medical assistance and medical staff visits, while assuring a certain degree of confidence on their health. With this idea in mind recent projects propose the combination of BSNs and mobile devices to perform personal health control and monitoring, with the added benefit of portability. The widespread of these devices in the general population, where sometimes people carry more than one device, emerges as a perfect computational platform that can be used in personal health monitoring, providing convenient BSN interface functions (Rodrigues, Pereira, & Neves, 2010). Several projects based on interconnection architecture of BSNs and mobile devices were proposed (Gao et al., 2008; Guo et al., 2008; Zhang et al., 2006). Most of these solutions need a permanent connection between the BSN and the mobile device, because sensors and/or sinks do not have the ability to save the collected data on-board. Connection energy costs also can decrease dramatically the lifetime of sensors' batteries. The inclusion of an embedded mass-storage memory module in the sensors' hardware platform can suppress the need for continuous communication between BSN and mobile device. The monitor-

ing and processing of gathered data by the body sensors may be performed either in real-time or in off-line modes. The real-time mode requires continuous BSN connection with the mobile device (Kulkarni & Öztürk, 2007), while the off-line mode is performed by mobile device demand, presenting previously collected data. As a result, the use of mobile devices became naturally a great solution for long-term patient's monitoring, for their processing power, memory capacity and the fact that a great percentage of the population is willing to carry this type of device.

This paper describes a mobile approach, based on Symbian operating system (OS) powered mobile devices, used for BSN monitoring. The system architecture comprises the following two main modules: i) body sensors for bio-signals acquisition and storage, and ii) a Symbian OS device with the proposed mobile tool for data presentation and monitoring. The system allows both real-time and off-line operation modes. The data collection process supports the off-line mode through the inclusion of a microSD module in the sink node(s). When the system interacts with a sink node the data is transferred to the mobile device for processing and presentation. The use of this onboard module avoids data lost when the communication between the BSN and the mobile device is unavailable.

The remainder of the paper is organized as follows. First, we summarize some research projects on mobile and personal health monitoring, while presenting a BSN sensor platform used in this system for patients' bio-signals collection. As an example, a temperature sensor to collect women core-body temperature is presented. The construction of the firmware used on the sensor is described, while the Symbian application is then addressed, describing system architecture, Bluetooth communication and security, and data representation. The user interface is shown in next, and the deployment and system validation is described following. Finally, a conclusion and further research areas are presented.

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