Chapter 8
Sensor Networks Security for Pervasive Healthcare

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ABSTRACT

Body-worn sensors and wireless interconnection of distributed embedded devices facilitate the use of lightweight systems for monitoring vital health parameters like heart rate, respiration rate and blood pressure. Patients can simply wear monitoring systems without restricting their mobility and everyday life. This is particularly beneficial in the context of world's ageing society with many people suffering chronic ailments. However, wireless transmission of sensitive patient data through distributed embedded devices presents several privacy and security implications. In this book chapter the authors' first highlight the security threats in a biomedical sensor networks and identify the requirements that a security solution has to offer. Then the authors' review some popular architectures proposed in the bibliography over the last few years and they discuss the methods that they employ in order to offer security. Finally the authors' discuss some open research questions that have not been addressed so far and which they believe offer promising directions towards making these kinds of networks more secure.

INTRODUCTION

One of the major challenges Information and Communication Technologies (ICT) have to cope with is to deliver healthcare to citizens at high quality and affordable costs. In particular, this challenge has to be considered in the light of prevalent trends in healthcare, such as prolonged medical care for the ageing population, increasing expenses for managing chronic diseases, and the demand for personal health systems. Research on this challenge aims at the creation of an "intelligent environment" in which the health status of any given individual can be monitored and managed continuously, which will assist health professionals in addressing major health problems.

A promising technology that can enable the above vision is biomedical wireless sensor networks

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(BWSN), which consist of body-worn sensors and wireless interconnection of distributed embedded devices. The emergence of low-power, single-chip radios has allowed the design of small, wearable, truly networked medical sensors. These tiny sensors on each patient can form an ad hoc network, relaying continuous vital sign data to multiple receiving devices, like PDAs carried by physicians, or laptop base stations in ambulances (Shnayder, Chen, Lorincz, Jones, & Welsh, 2005). In this way, we can provide lightweight pervasive health systems for monitoring vital health parameters, like heart rate, respiration rate and blood pressure, and help patients - and their doctors - monitor and manage their health status. According to a report released recently from OnWorld, San Diego, CA, the use of wireless sensor networks is growing within the healthcare industry, and the technology could save the healthcare industry billions of dollars in 2012 by reducing hospitalizations and extending independent living for seniors (Mareca Hatler, 2008).

Several research proposals that have been presented on the application scenarios of wireless sensor networks reveal the benefits of this technology in healthcare. We can classify these benefits according to the following three main categories:

Patient Monitoring at Home

Biomedical sensor networks allow monitoring of the patient at home, so that the elderly or patients with chronic diseases can enjoy treatment and medical monitoring in their own environment and provide a unique opportunity to shift health care outside a traditional clinical setting to a patient/home-centered setting. By monitoring continuously these people's health over a period of time, physicians can provide more accurate diagnoses and better treatment. For instance, monitoring patient data can help with early detection of conditions like heart disease. Moreover medical professionals could react to situations such as strokes and asthma attacks more quickly.

Patient Monitoring in the Hospital

Biomedical sensor networks substantially increase the efficiency of treatments inside the hospital environment. Today biomedical sensors are wired, attaching patients to machines, in order to read different values of vital data. The implementation of a more flexible wireless technology can lead to improved data quality, data resolution and increase of patient's mobility outside the surgery room. This results in enhanced decision making for diagnostics, observation and patient treatment.

Biomedical sensor networks can also be applied to cases prior to surgery. For example, overcrowding occurs in 40% of all Emergency Rooms in the U.S., where patients wait on the average of 3.5 hours before being seen by a doctor. This has caused a number of deaths in waiting rooms of urban hospital emergency rooms. Wireless sensor nodes can be used to monitor the vital signs of patients who are scattered in the waiting rooms and hallways of the ER waiting to be seen by a doctor. Information is transmitted wirelessly to a central monitoring system. If a patient becomes unstable, medical professionals could be alerted more quickly and provide a more immediate response.

Emergency Response

Disasters present a number of challenges to sensors due to unique patient, user, and environmental needs. Casualties can be distributed over areas well outside the communication range of pre-installed wireless access points. Wireless sensor nodes can be distributed to casualties at a disaster scene and relay sensor data - including vital signs, location, and triage status - over an ad-hoc mesh network to monitoring stations. In this way, members of the distributed response team, such as treatment officers, incident commanders, receiving hospi-