Chapter 4
Patient Tracking in Critical Scenarios

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ABSTRACT

This work describes the work-in-progress aimed at the design of a telemedicine system that is intended to give support to the physicians in critical scenarios and keep a record of the patient status within all the evacuation chain. The authors call this system a Patient Tracking System (PTS). The hardware/software platform described will integrate the services and functionalities available from the existing e-health infrastructure and provide the physicians with a decision support system in remote and hard-to-reach areas. The main goal is building a simple network hierarchy relying on two kinds of mobile devices: 1) a low-power Medical Information Carrier (MIC), and 2) an MDA (Medical Digital Assistant). A MIC is a device intended to hold personal medical information that may be accessed by a physician through a specialized terminal (the MDA) and, when suitably programmed, may emit a beacon signal to allow patient tracking along the evacuation chain. It is anticipated that our design will contribute to improve the efficiency in the use of communication resources in telemedicine. In a more general way, this project should enhance our understanding of the limitations that hardware and software impose on the operation in critical scenarios.

1. INTRODUCTION

The fast and ever increasing development of new wireless technologies and standards is revolutionising the conventional e-health systems and impelling the migration from fixed to mobile platforms, disclosing new possibilities and business opportunities. Wireless technologies may ease remote monitoring of life constants, allow the implementation of teleconsulting services, and drastically improve clinical information spreading and management by allowing the creation of a flexible system, easily deployable in any site.

In this scenario, information and communication technologies are a powerful tool that permits

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breaking time and space barriers that have been always an obstacle to effectively providing any medical treatment. In the current scenario of telecommunication services, mobility is one of the fundamental pillars for the development of new technologies and applications. In such a context, the wireless networks are experiencing remarkable technological advances, particularly ad-hoc wireless networks.

A mobile, wireless, ad-hoc network (Bulusu, 2005; Zhao, 2004) is a collection of mobile nodes that are dynamically and arbitrarily located in a certain region. The dynamic character of the nodes implies that the interconnections among them, the network actual topology, may change with time frequently. The main feature of these networks is that routing is performed by the nodes in the absence of a fixed infrastructure. The nodes act as routers which discover and maintain routes to other nodes in the network. The network itself emerges as the result of a collective effort of self-configuration of the nodes deployed.

Since mobile nodes are required to probe their surroundings trying to find routing nodes, and nodes are essentially hand-held terminals operated with batteries, power consumption is of paramount importance in the operation of these networks.

Ad-hoc networks have been proposed in many communications and remote-sensing settings (Boric-Lubecke, 2002; Juang, 2002; Mainwarig, 2002; Martínez, 2004; Riem-Vis, 2004). We are particularly interested in telemedicine and save-and-rescue (SAR) scenarios, both civil and military. In these scenarios, troops and civil personnel, globally deployed, require a framework to support and optimize medical decisions and processes on the battlefield or in hard-to-reach areas where time and environmental conditions make not possible or advisable the installation of a previous infrastructure. The description of such framework is the main purpose of this work.

2. TECHNOLOGICAL ISSUES IN PTS DESIGN

The design of a PTS is not an easy task since it implies the integration of several technologies ranging from Very Large Scale Integration (VLSI) technologies for implementing the Medical Information Carrier (MIC), to Information and Communication Technologies (ICT), for implementing support software and firmware to allow the MIC to communicate to the outside world and to build-up mesh networks with other similar devices, and to implement the software interface with the existing e-health infrastructure.

The main goals of a PTS are: (1) improving and speeding up the quality of diagnostics, and (2) supporting medical personnel, rescuers and first responders in their tasks, namely, the prevention of disease, treatment of sick and injured patients, and patient evacuation and hospitalization. A great effort is being carried out to develop wireless systems that keep a record of patient status during all the evacuation chain, for both military and civil applications (Penwill, 2008; Swedberg, 2006). Penwill (2008) reports a wireless dog-tag derived from the Personal Information Carrier (PIC) developed by Physical Optics Corporation. The device is intended to keep the medical record of a soldier, and may be accessed through an IEEE 802.15.1 (Bluetooth) wireless link with no tracking capability. Swedberg (2006) describes the Belgian Victim Tracking and Tracing Systems (BeViTTS). This system has been derived from the Dutch VTS (Victim Tracking System) and relies on a Wi-Fi (IEEE 802.11) RFID active tag. The tag is stored into a bracelet, whose colour identifies patient status (for example, black for “dead”, red for “urgent care required”, etc.).

The patient tracking system described in this work was originally designed for military applications; however, it may be easily adapted for civil applications as well. The system has a set of common features with those described by Penwill (2008) and Swedberg (2006): the MIC has the