Chapter 3.7
Mobility Support in 4G Heterogeneous Networks for Interoperable M-Health Devices

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ABSTRACT

In the last years, much work has been done to create a complete solution in m-Health environments. The problem can be summarized as follows: any health professional (medical specialist, sport trainer, nutritionist, etc.) should be able to control a series of measurements related to a person's health. The characteristics of these people vary from those patients with limited knowledge of the control processes and low mobility to sportsmen highly involved in the process and great mobility in the moment the measurements take place. This wide set of characteristics raises two basic challenges: the use of measurement equipment easily adaptable to the control system and the necessity of adding mobility support mechanisms to the design. This chapter focuses on studying these two challenges, illustrates them with several use cases and contributes to the mobility support problem with a new algorithm.

INTRODUCTION

Telecommunications and advanced information technologies have increasingly been used for clinical activities and research to improve healthcare delivery. The design of these e-Health systems has boosted many evolutions in the last years towards integrated solutions and new application environments. Thus, Medical Devices (MDs) and Vital Sensors (VSs) at the Point of Care (PoC) end are now part of very diverse environments: home telemonitoring, mobile solutions (m-Health) for teleemergencies, or on-line follow up while patients

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carry out their daily living activities (Ruiz, Viruete, Hernández, Alesanco, Fernández, Valdovinos, Istepanian & García, 2006). These devices and sensors acquire huge amounts of very valuable information, without the need for manually writing down each measurement, contributing to the generation of the Electronic Healthcare Record (EHR). Moreover, as different manufacturers use their own software and communication protocols (building proprietary solutions that can only work alone or inside a single-vendor system), an important interoperability problem emerges, leading to the need of communication standards (Galarraga, Serrano, Martinez & Toledo, 2005), and their further adaptation to new wireless (Bluetooth, Zigbee, or WiFi) and wired (USB or Ethernet) communication technologies. Some of these standards are EN13606, the European standard for EHR communication (EN13606, 2007); and ISO/IEEE11073 PoC-MDC, the European CEN/TC251 family of standards for PoC-MD Communications also known as X73 (IEEE11073, 2007). Thus, this need for developing open sensor networks in healthcare environments has fostered the development of standard-based specific solutions (Martínez, Fernández, Galarrage, Serrano, Toledo & García, 2007) that allow transparent integration and interoperability inside e-Health systems with monitoring medical devices. Furthermore, the use of standards provides plug-and-play capabilities and auto-configuration features with the lowest level of user intervention, also taking into account users with no technical knowledge (the end user, without the support of a technician, should also be able to substitute or add a device in case of failure or due to a change in the follow-up design).

From this scenario, and in order to propose global e-Health solutions, all this interoperability effort must be integrated in a design scheme to support a network of compatible devices from different patients in different locations (see Figure 1). Thus, information data acquired from the different MDs and VSs is transmitted in a standards-compliant mode to a compatible e-Health device that acts as a gateway. This compatible e-Health device in each PoC connects to the monitoring server to manage different e-Health services, and its design must adapt to the new relevant scenarios in addition to those based on traditional fixed networking. Thus, the e-Health device design must support two additional connection modes: portable (in supervised environments but with changing requirements), and mobile (with changing both environments and requirements). First, in a portable networking scenario, the device design requires allowing intra-network connections and communications to any access network, in order not to depend on the specific requirements related to each fixed location. However, the design does not require continuing the ongoing communication between communicating peers during movements. In a complementary way, a mobile networking scenario requires services to continue ongoing communications while roaming, preferably without interruption or the degradation of communication quality. In fact, the first scenario can be regarded as a special case of the second scenario. Likewise, devices must adapt to the available (wired and wireless) connection technologies, and be able to communicate to several access technologies and seamlessly move between them in an Internet Protocol (IP) environment. These requirements involve the integration between heterogeneous networks, known as 'all-IP,' including mechanisms to provide mobility support for roaming devices and efficient seamless vertical handoff (or handover) schemes to enhance Quality of Service (QoS) and provide flawless mobility (Le, Fu & Hogrefe, 2006).

Today many things have changed in the traditional TCP/IP networks with the deployment of mobile devices, in particular in relation to the scenarios previously described and their service requirements when a mobile device moves across wireless networks. In this situation, its location may change frequently and, therefore, its IP address may change accordingly. Due to the changes of IP address, the ongoing connections of

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