Chapter 2.9
The M-Health Reference Model:
An Organizing Framework for Conceptualizing Mobile Health Systems

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ABSTRACT

The reference model presented in this article encourages the breakdown of M-Health systems into the following five key dimensions: (1) Communication Infrastructure: a description of mobile telecommunication technologies and networks; (2) Device Type: the type of device being used, such as PDA, sensor, or tablet PC; (3) Data Display: describes how the data will be displayed to the user and transmitted, such as images, e-mail, and textual data; (4) Application Purpose: identification of the objective for the M-Health system; (5) Application Domain: definition of the area in which the system will be implemented. Healthcare stakeholders and system implementer can use the reference model presented in this article to understand the security implications of the proposed system and to identify the technological infrastructure, business requirements, and operational needs of the M-Health systems being implemented. A reference model that encapsulates the emerging M-Health field is needed for cumulative progress in this field. Currently, the M-Health field is disjointed, and it is often unclear what constitutes an M-Health system. In the future, M-Health applications will take advantage of technological advances such as device miniaturizations, device convergence, high-speed mobile networks, and improved medical sensors. This will lead to the increased diffusion of clinical M-Health systems, which will require better understanding of the components that constitute the M-Health system.

INTRODUCTION

M-Health is defined as "mobile computing, medical sensor, and communications technologies for

healthcare" (Istepanian, Jovanov, & Zhang, 2004, p. 405). The first occurrence of the term *M-Health* in the literature was in the "Unwired E-Med" special issue on Wireless Telemedicine Systems (Istepanian & Laxminaryan, 2000). Since then, there has been an increased use of the term, encapsulating various types of healthcare systems. The use of the M-Health terminology relates to applications and systems such as telemedicine (Istepanian & Wang, 2003), telehealth (Istepanian & Lacal, 2003), and biomedical sensing system (Budinger, 2003). Until now, there have been considerable confusion and overlap with the use of these terms (Tulu & Chatterjee, 2005).

Rapid advances in Information Communication Technology (ICT) (Godoe, 2000), nanotechnology, biomonitoring (Budinger, 2003), mobile networks (Olla, 2005a), pervasive computing (Akyildiz & Rudin, 2001), wearable systems, and drug delivery approaches (Amy et al., 2004) are transforming the healthcare sector. The insurgence of innovative technology into the healthcare practice not only is blurring the boundaries of the various technologies and fields but also is causing a paradigm shift that is blurring the boundaries among public health, acute care, and preventative health (Hatcher & Heetebry, 2004). These developments not only have had a significant impact on current e-health and telemedical systems (Istepanian, Jovanov, & Zhang, 2004), but they also are leading to the creation of a new generation of M-Health systems with a convergence of devices, technologies, and networks at the forefront of the innovation.

This article proposes the use of a five-dimensional reference model in order to assist system implementers and business stakeholders in understanding the various components of an M-Health system. The approach used by the this article focuses on identifying different dimensions of a Mobile Healthcare Delivery System (MHDS) (Wickramasinghe & Misra, 2005), which then can be used to identify user security requirements for different categories in an organized manner. These dimensions were driven from our literature review (Bashshur, 2002; Bashshur, Reardon, & Shannon, 2000; Raskovic & Jovanov, 2004; Istepanian, Laxminaryan, & Pattichis, 2006; Jovanov, Milenkovic, Otto, & Groen, 2005; Field, 1996; Moore, 2002; Olla & Patel, 2003), and the model reflects a combination of various classification schemes proposed in earlier studies in order to classify telemedicine and telehealth systems.

Based on the previous definition, M-Health is a broad area that transcends multiple disciplines and utilizes a broad range of technologies. There is a variety of applications, devices, and communication technologies that are emerging in the M-Health arena and that can be combined to create the M-Health system. The dimensions consist of the following:

1. **Communication Infrastructure.** Description of the mobile telecommunication technologies that will be used, such as Bluetooth, wireless local area networks, or third-generation technologies (Olla, 2005a).
2. **Device Type.** Relates to the type of device being used to collect the medical data, such as Personal Digital Assistance (PDA), sensor, or tablet PC (Parmanto, Saptono, Ferrydiansyah, & Sugiantara, 2005).
3. **Data Display.** Describes how the data will be displayed and transmitted to the user through images, e-mail, textual data, and other types of data presentation languages (Tulu & Chatterjee, 2005).
4. **Application Purpose.** Identification of the objective for the M-Health system (Field, 1996).
5. **Application Domain.** Definition of the area in which the system will be implemented, such as clinical (e.g., dermatology, radiology, etc.) or non-clinical (e.g., billing, maintenance, etc.) domains (Bashshur et al., 2000).