

Chapter 1

A Comprehensive Overview of Wireless Body Area Networks (WBAN)

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ABSTRACT

In recent years, the wireless body area network (WBAN) has emerged as a new technology for e-healthcare applications. The WBANs promise to revolutionize health monitoring. However, this technology remains in the first stages and much research is underway. Designers of such systems face a number of challenging tasks, as they need to address conflicting requirements. This includes managing the network, the data, while maximizing the autonomy of each network node. Reducing the consumption of a node, the management of network resources and security insurance are therefore major challenges. This paper presents a survey of body area networks including the WBANs challenges and -architecture, the most important body sensor devices, as well as sensor board hardware and platforms. Further, various applications of WBANs in the medical field are discussed, as well as wireless communications standards and technologies. The newest researches related to WBANs at physical and MAC layers are presented. Finally the paper identifies data security and privacy in WBANs as well as open research issues.

INTRODUCTION

Recent advances in wireless communication technologies and “MEMS” (micro-electro-mechanical systems) (Arshak et al., 2005) fields have enabled the development of micro-components that

incorporate sensing devices and wireless communications into a single miniature circuit, with a reasonable cost. These components, are known as micro-sensors, have promoted the idea of developing sensor networks (Lewis, 2004; Sohrawy, Minolti, & Znati, 2007) which are based on the collaborative effort of a large number of nodes

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operating autonomously and communicating with each other via short-range transmissions. In addition to civilian (Dishongh & McGrath, 2010), military (Akyildiz, Su, Sankarasubramaniam, & Cayirci, 2002) and environmental (Akyildiz, Su, Sankarasubramaniam, & Cayirci, 2002; Cerpa & Estrin, 2001) applications of wireless sensors networks (WSN), the use of WSN for healthcare (Bauer, Sichitiu, Istepanian, & Premaratne, 2000) has considerable interest in the development of wireless networks around human body to monitor body functions and the surrounding environment. These categories of networks are known as Wireless Body Area Networks (WBANs) (Bilstrup, 2008; Donovan, Donoghue, Sreenan, Sammon, Reilly, & Connor, 2009; Moutinho, 2009). Actually recent efforts promote the development of new protocols and standards related to WBAN. The Institute of Electrical and Electronic Engineers (IEEE) approved the formation of a working group for IEEE 802.15.6 (IEEE Standards Association, 2008, 2009), intended to endow a future generation of short-range electronics-both in body and on or around it. A set of standards known as ISO/IEEE 11073 or X73 (IEEE Standards Association) are providing interoperability for patient connected medical devices and facilitating the efficient exchange of vital signs and medical device data in all healthcare environments. WBANs technologies will play a significant role in enabling ubiquitous communications and revolutionize healthcare systems. WBANs aim to facilitate health monitoring (Virone et al., 2006), medical care (Pomalaza-Ráez, 2007), and healthcare delivery in ambulances (Otto, 2006) and in emergency rooms (Gao et al., 2008), and assistance to people with disabilities. Therefore, WBAN is found to be a key element in the infrastructure for patient centered medical applications (Pervez, Asdaque, & Kyung, 2009). Medical applications can be wearable (Hung, Zhang, & Tai; 2004) and implanted (Graichen, Arnold, Rohlmann, & Bergmann, 2007). Wearable WBANs are considered for both medical and non medical applications however

implanted WBANs are mainly considered for medical and healthcare applications. Wearable devices are those that can be used on body surface of a human. The implantable medical devices are those inserted inside human body. WBANs have drawn a lot of attention from the research community during the last years. Many research papers present surveys, studies and overviews wireless body area networks, each paper deals with specific issues.

In Chen, Gonzalez, Vasilakos, Cao, and Leung (2010) the authors present a survey of WBANs, taxonomy of WBAN projects and application also; they have discussed WBAN communications architectures. Moreover, they review body sensor devices, as well as sensor board hardware and platforms and they provide a detailed investigation of current proposals in the physical and data link layers. Besides that, they highlight some design challenges and open issues that still need to be addressed in future research.

In Ullah et al. (2010) the authors evoked the WBAN architecture and they present a study of wireless body area networks mechanisms at physical (PHY), medium access control (MAC), and networks layers. They highlight different methodologies and mechanisms of these layers and they have proposed different solutions for each layer. Many applications are enumerated that are the in body, on body medical applications and on body non-medical applications.

In Pantelopoulos and Bourbakis (2010) the authors introduce a survey on wearable sensor-based systems for health monitoring and a comparison of system implementations was elaborated in order to choose the most important characteristics, which describe the functionality of systems.

In Cao, Leung, Chow, and Chan (2009) the authors provide research projects and applications of WBAN for healthcare and for HCI (human computer interaction), also they explore sensors devices which are the key components of wireless body area networks, radios technologies and connection of WBAN. In addition to that,

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