# Creating XML / PhP interface for BAN interoperability

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**Abstract.** Recent advances in medical and electronic technologies have introduced the use of Body Area Networks as a part of e-health, for constant and accurate monitoring of patients and the transmission as well as processing of the data to develop a holistic Electronic Health Record. The rising global population, different BAN manufacturers and a variety of medical systems pose the issue of interoperability between BANs and systems as well as the proper way to propagate medical data in an organized and efficient manner. In this paper, we describe BANs and propose the use of certain web technologies to address this issue.

**Keywords.** ehealth, BAN, XML

## 1. Introduction

Nowadays medical technologies and research on them are at their peak. Many products that monitor patients' health factors render constant patient "close monitoring"[2] obsolete. That is because many of these products have biometric sensors which[V1] use the intake of values and compare them with risk factors to warn the patient or the physician about the current condition and the next steps that need to be taken by either party to avoid a severe situation. Moreover, the use of biometric sensors creates an extreme volume of data that must be manipulated to extract the information needed. As an example, the use of Electronic Medical Record (EMR), Electronic Health Record (EHR) and Personal Health Record (PHR) [1] posed the issue of data transfer between different systems and devices as well as the issue of manipulating those data to be available. Targeting this issue, we present a methodology of using Web Technologies to achieve a transfer of data in an organized manner that can be adopted by different system and Body Area Network (BAN) manufacturers. The purpose of this is to offer interoperability for devices of different vendors so that data gathered by one system can be available and translatable by a different manufacturer's system[V2].

## 2. BANs

Advances in Internet of Things (IoT) and Information and Communication Technology (ICT) has enabled the need of integrating Body Area Networks (BANs) in healthcare. BANs are comprised of a plethora of heterogenous biometric sensors which are either

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[2] We use the term "close monitoring" to distinguish the proximity of the monitoring. For "close monitoring" we mean that a health professional must be physically close to the patient so he or she can take the patients' vital measurements and document them on a piece of paper

Wearable Medical Devices (WMDs) or Implanted Medical Devices (IMDs) and are used for measuring changes in a patient's vital signs [2] [3] [4]. This large amount of data [5] is to be stored, processed and analyzed in order to provide constant health monitoring for patients individually to help keeping an updated and detailed PHR. With a detailed PHR patients can keep track of their health and can present their physician the data needed for further diagnosis or treatment. Wireless technology advancements have led to the emergence of WBANs (Wireless Body Area Networks). WBANs can be supported by the use of Wi-fi, Bluetooth, ZigBee (for personal area networks) [6] [7], RFID (Radio Frequency Identification), IEEE 802.15.6 (WBAN standard) and more [8]. Since the number of BAN manufacturers is increasing, different technologies are at hand as so as in different medical systems that use BANs. Moreover, the number of people that are to use this kind of equipment is about to double until 2050 [9], leading to an immense increase of data to be processed and stored [5]. Therefore, the issue of interoperability of BANs [10] so that sensor data not to be isolated in a local system, is to be addressed.

## 3. BAN: deployment of an ECG sensor

What we are proposing is the design and implementation of an interface that uses Web Services to support the development of medical related applications on low cost devices. We created a web based interface that is commonly acceptable which can be used by Body Area Networks' (BANs) manufacturers and e-health programmers. This leads to an initial solution of the interoperability issue and the sharing of biometric and medical information, thus facilitating the establishment and usage of EHRs and PHRs. In order to do so, we propose the use of XML (eXtensible Markup Language) as the basis of a structured and light way of sending massive amounts of data through networks. This is because XML has been created for large scale electronic publishing and to facilitate the exchange of a wide variety of data in networks [11]. Since XML data structure is embedded with the data, the sharing of information is consistent. Moreover, the data are in plain text format, so there is independence of software or hardware [12]. To create the data structure, we take advantage of XSD (XML Schema Definition). Moreover, we use PHP (Hypertext Preprocessor) to simulate a server – side reception, processing and transmission of data to verify the proposed way and its functionality. With the use of an Arduino Uno microcontroller, a low-cost hardware platform which in our project acts as a server, we will be able to receive data from the biometric sensors attached to e-Health Arduino Shield and make them available by transmitting them using an XML format in a network of a plethora of connected devices.

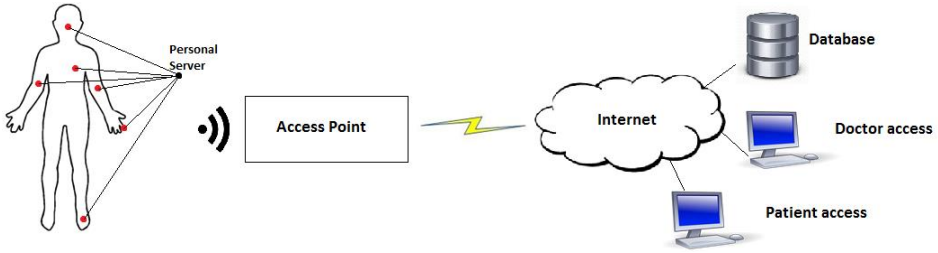


Figure 3-1: Connectivity of a WBAN

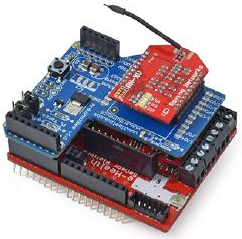

Figure 3-3: Personal Server

Figure 3-2: E-health Arduino Shield with ECG sensor leads connected on it.

As an example, we take the ECG sensor operation. The personal server (Figure 3-3) [13] comprises of an Arduino Uno microcontroller, an e-health Arduino Shield and a Wi-Fi module. After uploading the compiled code on the microcontroller, it starts receiving data from the ECG sensor (Figure 3-2) [13]. The data collected are time and voltage values separated by a delimiter (here is the semicolon). By using PHP, the microcontroller acts as a server and while it receives data periodically, it uses XML variables (<time>, <ECG_voltage>) to organize them with tags. Following this, the server validates the labels and the format of data using the schema provided in XSD and then it makes them available to be stored in the server's memory. From now on, these data are available to be accessed via a user's GUI or by any other application that uses these data to build database records that can then be added to existing or create new Electronic Health Records. This enables every software engineer or programmer to take an existing interface and use it to fit the needs of their projects. As a result, more database systems can be updated to use a global format in order to overcome the previously mentioned issue of interoperability.

## 4. Discussion

Medical sensors and BANs play a vital role in modern medicine for creating and maintaining a detailed and accurate EHR. As global population grows and medical technologies advance, the amount of data to be stored and processed increases geometrically. In addition, different medical system and BAN technologies pose an issue of interoperability. With the use of the interface proposed, we manage to share data between different technologies of BANs seamlessly, without hardware or software dependencies. In the future, this can be used by programmers of medical software and systems to establish a standard way of interconnecting BANs and sharing the data received through networks to create, enhance or modify EHRs. Upon completion of this task, the interface proposed can be applied in a hospitalized environment in order to achieve a global interconnection of establishments so that patients' data are available to each physician in the world. This could also reinforce medical research of professionals or students in the field, by providing case studies with actual data.

Since this is an ongoing project, one of the great issues at hand is gathering raw data from each vendor's system and structuring them with our proposed scheme, since the amount of companies in the field is vast and procuring each device is somewhat troublesome.[V3]

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