Volume : 2 | Issue : 6 | June 2013 • ISSN No 2277 - 8160

Research Paper

Engineering

# Service Based Architecture for Wireless Homecare System

**Ching-Sung Wang**

Department of Electronic Engineering, Oriental Institute of Technology, Taipei, Taiwan, R.O.C.

**ABSTRACT**

*In this paper, we design a service based architecture for wireless homecare system, the system compose by three parts: variety of physiological measuring devices, the embedded smart devices and remote monitor database. The user can use the difference physiological measuring devices obtain their information and store them in the embedded smart devices which could be a smartphone or e-PAD. Here we define XML (extensible markup language) as a tool to unify the record formats in different medical institutes. Thus the proposed health-care network can play a role of bridge at medical information exchange. Also the user can use smartphone to access advice from doctor or physiological information. The doctor can monitor their patient information through the remote monitor database. Moreover, such an integration service can significantly reduce the medical staff's diagnosis time.*

**KEYWORDS: wireless homecare system; physiological measuring devices; XML, remote monitor database**

## I. Introduction

In recent years, the network technology is rapid development. People try to combine medical care with cloudy service reach to daily medication reminders, physiological information automatically recorded, abnormal situations of emergency notification and online medical consultation they expect to reduce the huge medical costs and labor fee [1]. In health monitoring system, there are many devices with wireless data transmission such as electrocardiography (ECG) monitoring system [2]. There are many wireless transmission technologies like Bluetooth, ZigBee and radio frequency transmission can choose. The Bluetooth mostly use in smart device with low power, low cost and high security. The device with Bluetooth only authentication once and they can access data between in smart devices [3].

The medical information service platform can provide the data of physiological measuring device upload, store, real-time exception notification and online physiological measuring data query service that are closed system with special function and particular data format. We use service oriented architecture (SOA) system architecture that can combine variety of heterogeneous systems and that can integrate all wrapped services and implement a standard interface with external communication. The advantage is to reduce redundancy design and development time of the healthcare service systems [4]. We can compile the record electronic health record (EHR) by capture and recode the physiological measuring data for a long period. The EHR data format is converted to the electronic medical records (EMR) that is based on the Health Level 7 clinical the document architecture that was released 2.0 (HL7 CDA R2). The EMR is the reference when the doctor diagnosis or health care personnel associated services [5].

## II. System ARCHITECTURE

This study designs interactive and multi-functional Web interfaces for a tele-healthcare system using the Smarty Web template framework. The system uses service-oriented architecture (SOA) and the standard structure of HL7 to exchange health information, the ease of information exchange with other medical record systems is also considered. Additionally, this system transmits the users' physiological measures such as pulse, blood oxygen levels, blood pressure, and electrocardiograph results to the system via Bluetooth wireless transmission technology. According to the requirements of the architecture of the remote care services, we construct our design to three parts: variety of physiological the measuring devices (PMD), embedded smart devices (ESD), the remote monitor database (RMD) shows on figure 1.

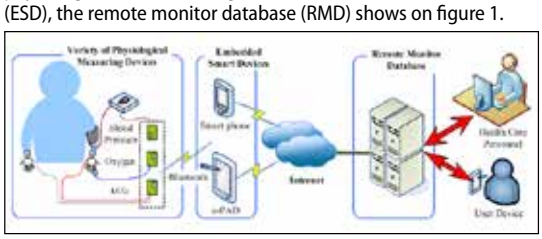

**Figure 1. Overview of the System.**

According to the European heart journal the cardiovascular disease is a chronic disease, if persistent long-term observation it will be able to reduce mortality [6]. Therefore, the PMD provide three kind of physiological measuring devices that are blood pressure, blood oxygen and electrocardiography. The device can capture the human physiological data and sent them to embedded smart device through Bluetooth transmission technology. The ESD receive the physiological measuring data that will synchronous display them and present on the screen by concise manner. The doctor or nursing staff can through this device immediately know the result of physiological measurement and track the patient's medical history information through the RMD.

The complete wireless physiological sensor designed by this study is shown in figure 2. During the measurement process, users wear the designed wireless physiological measurement device and conduct measurements according to normal use. Upon measuring, the device extracts and uploads the measured data to the host database. Users can also link to the Internet during the measuring process and launch the health management service platform on the Web page. By choosing real-time physiological monitoring, all the measured data is shown immediately on the Web page.

Figure 2. Integrated physiological measurement device.

## III. wireless homecare system

we design a service based architecture for wireless homecare system (SBAWHS) that includes PMD, ESD and RMD shows on figure 3. The PMD, we design for grab physiological data that own three functions. The first function is measuring blood pressure, we use pressure sensor to acquisition the pressure value and through the filtering and amplification unit reduce the noise and amplify signal. The second function is pressure oximeter, we use the infrared and red light as light source through the receiver to catch the oxygen signal and clamp the signal level. The last one is electrocardiography, we use the electrodes of EGC to get the signal through the noise elimination and amplification circuit signals pass to the signal processing circuit and MCU. Finally, these three kind of physiological signals using Bluetooth transmitter signal launched to ESD.

We designed a program to work on the existing smart device, and use it to receive, temporary storage and process simple data from the PMD

upload and interactive friendly interface will be display on screen of ESD. We use extensible markup language (XML) architecture to modify the file that defined by continuity of care document (CCD). Finally, those XML file will be uploaded to RMD through wireless network or third generation global system for mobile communication.

The SOA is composed by web service technology and standardized components that focus on businesses, schools or provide network services units to construct a flexible, reusable integration interface. It also promotes external as internal applications, users and departments perfect communication. In recent years usually has been used to integrate heterogeneous platforms. In this paper, we design a network service platform for health management based on SOA architecture use standard messages (such like XML) for data exchange. Therefore, the information can be displayed in other device. When new measurement of other physiological monitoring service or applied to health care system, only add or modify the content type of platform that can be reassembled at any time in accordance with the structural changes to reduce the time of re-design.

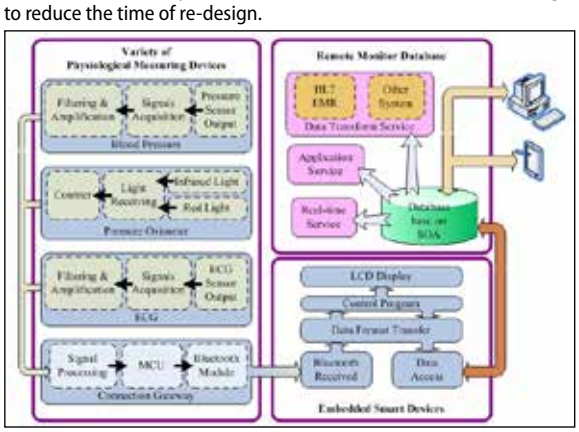


**Figure 3. SBAWHS system architecture.**

We designed a program to work on the existing smart device, and use it to receive, temporary storage and process simple data from the PMD upload and interactive friendly interface will be display on screen of ESD. We use extensible markup language (XML) architecture to modify the file that defined by continuity of care document (CCD). Finally, those XML file will be uploaded to RMD through wireless network or third generation global system for mobile communication.

The SOA is composed by web service technology and standardized components that focus on businesses, schools or provide network services units to construct a flexible, reusable integration interface. It also promotes external as internal applications, users and departments perfect communication. In recent years usually has been used to integrate heterogeneous platforms. In this paper, we design a network service platform for health management based on SOA architecture use standard messages (such like XML) for data exchange. Therefore, the information can be displayed in other device. When new measurement of other physiological monitoring service or applied to health care system, only add or modify the content type of platform that can be reassembled at any time in accordance with the structural changes to reduce the time of re-design.

### A. The flow chart and XML elements

In our study, the physiological measurement process uses the XML (eXtensible Markup Language) to compile the data format, with a high degree of scalability (Extensibility). The XML format was designed to send, carry and description of the data information between the cross-platform and widely use. They define the required element style through different documents (XSLT, CSS, etc.) to generate the corresponding HTML, PHP or other file formats and fit the data content, so they can effective information exchange between different platforms and services, data conversion can also be the objects with the service differ.

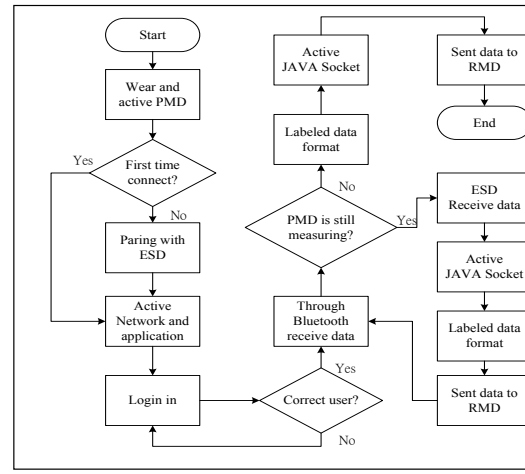


**Figure 4. The measuring flow chart.**

Figure 4 shows the flow chart process of blood pressure and physiological measurement. The user wears the cuff of sphygmomanometer in the arm, and power on the sphygmomanometer monitor then it will auto to connect to the PMD. Only at the first time, we need manual paring VPN and ESD then that will auto paring next time to use the PMD. When paring the ESD will active the application in the ESD and through the 3G or Wi-Fi network to communication with RMD.

The application in the RMD will determine whether user input the username and password correct or re-verified when they type wrong password. The system will load and monitor the physiological measurement data. So far, that complete the preparation measured physiological signal. ESD receives data from the PMD through the JAVA socket, the data which will be labeling and adding another messages become complete information as shown on Figure 5.

By using JAVA socket communication architecture that can quickly established a dedicated communication channel between on different devices and platforms. Base on TCP/IP structure, that can be owned data transmission of the process at the same time into error detection, confirm the data transmission of the correct and reliability that can avoid some problems, such as packet loss during transmission, resulting in incomplete data problems.

In data transfer processing, the RMD determine the start and end of data transmission by the root element shows on figure 5(b). When the RMD receives the starting element (SingleSignal) the first XML data that will be written in register until receives the ending element (/SingleSignal). Finally, the RMD will stop writing and dump data in register to the database. The RMD will clear the data in the register and interrupt JAVA socket and the ESD release resources and waiting for the next program execution.


**Figure 5. The variety of XML elements.**

Because when we measure the heart rate, oxygen concentration and cardiac signal which require continuous monitor the physiological measuring devices. Therefore, the process is somewhat different. The data transmitted through the Bluetooth module to the ESD that will judge the PMD whether the data continue output. When the continuous physiological signal is transmitting the ESD will add the (ContinuousSignal) element in the start of XML data and upload them to the RMD. When the user stop measuring physiological signal, the ESD will add the element (/ContinuousSignal) in the end of data and upload them to the RMD. The whole element shows on figure 5(c). Because the measurement of body temperature doesn't need continue transfer signal therefore they use the SingleSignal element and present on figure 5(d).

The RMD receive the physiological measuring data which are uploaded from ESD. That information will be classification and storage in medical database. The user access physiological measuring data stored in the RMD through the home health care platform (HHCP), the platform base on SOA model which provide areal-time physiological measurement data show that physiological measurement data query and warning services, CCD EMR output and other services

### B. Health Level 7

HL7 is mainly applied various types of medical information systems, such like the medical orders information systems, inspection systems, pharmacy information and management information systems which is a standards for interchange electronic data. HL7 develop for different types of electronic medical record information standard in nature of medical information. Also, they include the common standard: CDA (Clinical Document Architecture), CCR (Continuity of Care Record) and CCD (Continuity of Care Document).

The CDA provisions the encoding of structure and semantics of clinical documents for exchange. The CCR is used for patient the timeliness health care information, including a summary of the patient's health status and disease suffering insurance, pre-directives, healthcare file with the care plan recommendations, including patient identification information. The CCD combined HL7 CDA - R2 and ASTM CCR standard implementations that mainly used for continuous care record demand.

In our study which records the different physiological strategy process for a long period. We design the required data format and element base on the CCD format. Our continuity of care documents template reference the BIDMC (Beth Israel Deaconess Medical Center) and PPHC (Personal Physicians HealthCare) and modify the format for a long period of personal health care records. Finally, we increase the physiological measurement data recording element and follow the content of the information recorded in the measurement process.

## IV. Implementation Results

Figure 6 shows the PMD and ESD operation. The area A, B and C were blood pressure, blood oxygen and electrocardiography physiological measuring device. The area D and E is the smartphone and e-Pad belongs to ESD. The user wear the measuring device to test that follow our operation sequence. The result will display on the screen of ESD and store in the database of RMD.

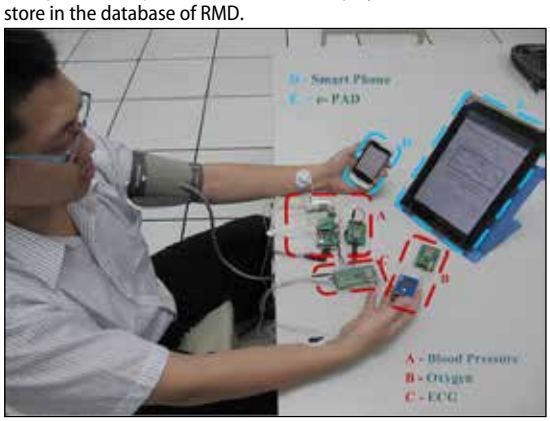


**Figure 6. SBAWHS Operating Process**

We wrote two applications which can display the measurement results on the smartphone or e-Pad that shows on the figure 7.

According to the measurement operating process, the ESD will update that information to the RMD. The resident doctors will immediately see the results on the measuring device and the doctor can immediately give some recommends to write back to the database. Finally, the user can print out the result of physiological measuring information (such as oxygen, blood pressure) and the system will update that information to the EMR.

Users can also query previous physiological measurements, such as history of blood oxygen levels and pulse records, as shown in figure 8. The system can display the measurement record of the date indicated by the user and show the blood oxygen levels and pulse (heartbeat) values using a histogram. This system provides one week, two weeks, and one month record query options for blood pressure record queries. The values of the selected range are displayed using a line chart, as shown in figure 9

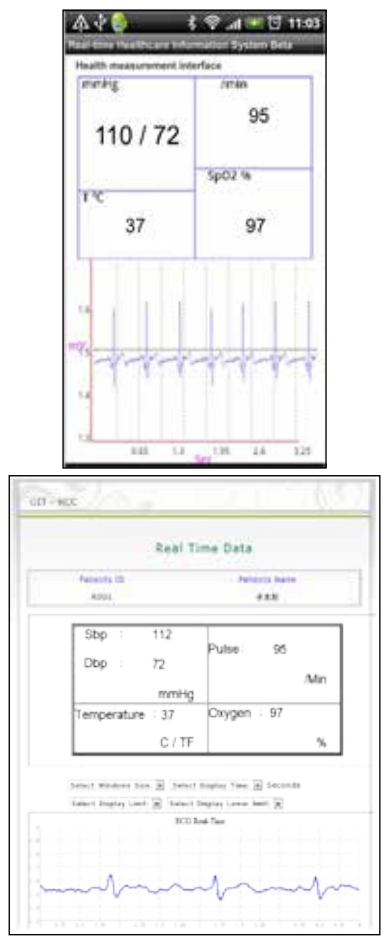


**Figure 7. The measurement results displayed on the smartphone and e-Pad.**

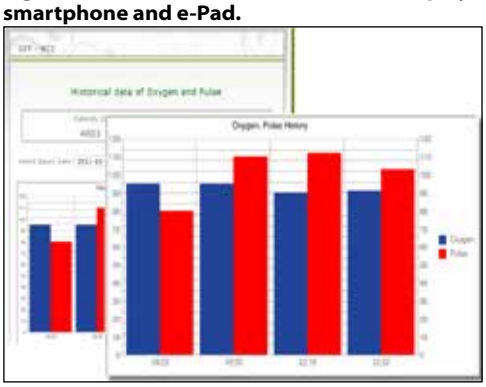

**Figure 8. Blood oxygen and pulse recording query function**

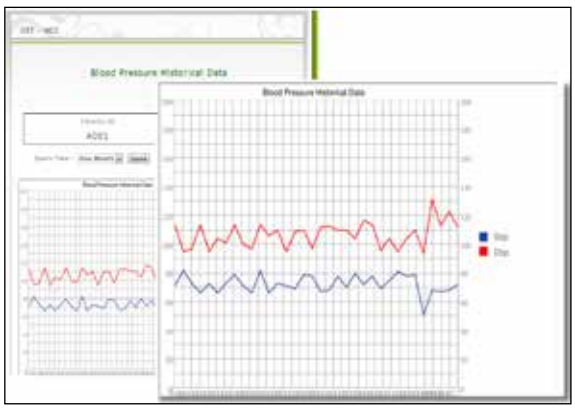

**Figure 9. Blood pressure record query functions**

In the RMD, we according to the hypertension classified standards by the World Health Organization (WHO). We graphed and presented the result that shows in figure 10.The color from lighter to deep relate with hypotension normal, prehyoertension and hypertension stage (1, 2, and 3). Here, we use different colors to represent the performance of different blood pressure, and the results are displayed in the remote computer or ESD.

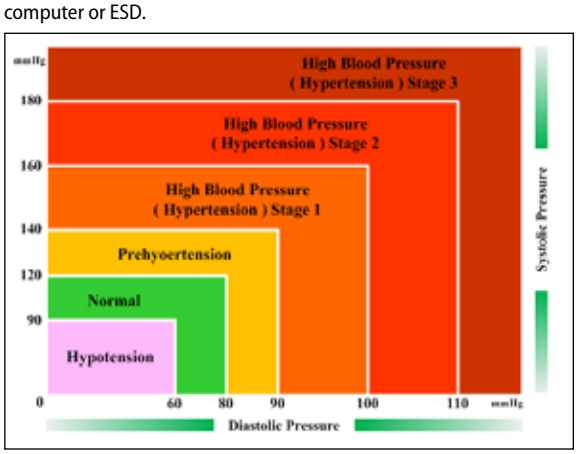


**Figure 10. The blood pressure classification graphic.**

Figure 11 present the real-time monitoring screen of five users in the RMD side. The user 1 has systolic blood pressure of 155mmHg and diastolic blood pressure of 96mmHg which display color is orange reference to figure 10.

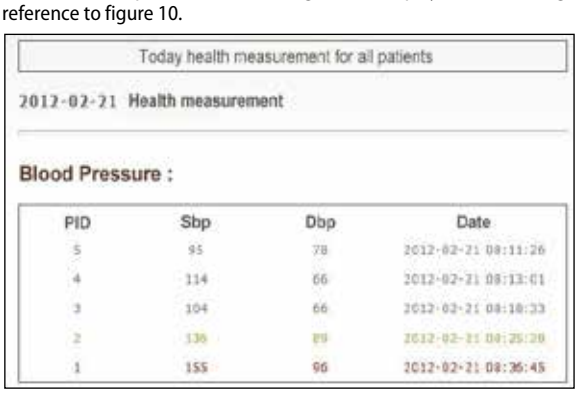


**Figure 11. The real-time blood pressure monitoring screen.**

We use Java Socket protocol communication between ESD and RMD. The Java Socket through the transmission control protocol (TCP) to transmit data not only provides error-free data transmission, debug, recovery and sorting data function but also you can ensure that the information is correct. The Java uses Unicode become standard characters that will makes Java programs can be written in different languages on the platform and implementation. Transfer data between RMD and ESD, we use the Read, Receive, Send and Write command transmission data. When the connection was broken the program use close socket command terminates and release system resources.

Compared to the other designs of homecare system, our system provide more friendly operation in patient and doctor side, people do not afraid the go to hospital for measurement. The design1 major proposed a game boy advance (GBA) carry embedded ECG measurement circuit based ECG data transmission will be received through self-designed cable transmission circuit and memory card to link the device storage [7]. The result also displayed the data on the LCD itself panel. The design which reduce the size although easy to carry and measurement but the ECG measurement data only can be stored and displayed on GBA or can not be shared with other devices.

The design 2 proposed a device in the body of the wireless transmission of physiological monitoring instrument which develop a convenient device and portable physiological monitoring instrument [8]. The design uses ZigBee become the wireless transmission between the physiological monitoring equipment and data receiving device. The information stored in the PDA through a GSM or Wireless function transmitted to another person or device that provide relevant medical staff to monitor the user status to achieve the long-term monitoring.

In this study, we design and integration physiological monitoring device based on physiological monitoring. We use Bluetooth protocol that reduces the additional development time of the communication module to enhance convenience. The measurement data are stored in the RMD through the install the application or online service platforms. The physiological measurement data can be displayed on different devices which help to improve the convenience of operation or inquiries. The related medical personnel can also be applied to medical care, health status and real-time remote monitoring. The result of comparison table shows on table I.

**TABLE I. Comparison Table with Other Design**

| | Design 1 | Design 2 | Our Design |
|---|---|---|---|
| Data transfer media | Wire | ZigBee | Bluetooth |
| Data storage location | Memory card | PDA | Remote database |
| Display measure-ing result | GBA | PDA | ESD and RMD |
| EMR output | None | Yes | Remote database |

## V. Conclusions and Future Work

This study established a tele-healthcare system that enables at home self-health management. This study also designed a Bluetooth wireless physiological measurement transmission device to measure the users' physiological condition. The Web services approach enables the saving and browsing of measurement records, which not only reduces problems related to having to install programs at the user end, but users can also monitor their measurement record through the Internet at any time. The cross-platform and cross-language features of Web services provide more flexibility in the use of the system and improve the promptness and convenience of message transmission between systems. This system uses XML for information transformation. Information is transformed into a format that conforms to the HL7 standard via XML, and therefore can exchange messages with various independent hospital information systems. Our design provides a physiological measuring device in home. People do not need to go to hospital registered they can use our design to get the same service just stay in home. Although, the user can query their history of EMR by login RMD to obtain the advice from doctor.

## REFERENCES

[1] C.O. Rolim, F.L. Koch, C.B. Westphall, J. Werner, A. Fracalossi, and G.S. Salvador, "A Cloud Computing Solution for Patient's Data Collection in Health Care Institutions," 2010. ETELEMED '10. Second International Conference on eHealth, Telemedicine, and Social Medicine, 10-16 Feb. 2010, pp. 95-99. | [2] Hanh Le, M. Kuttel, and G. Chandran, "An Electronic Health Care - Cardiac Monitoring System," 2010 IEEE International Conference on Communications Workshops (ICC), 23-27 May 2010, pp. 1-5. | [3] Majid A. Al-Taee, Nadine A. Jaradat, and Dima M. Abu Ali, "Mobile Phone-Based Health Data Acquisition System Using Bluetooth Technology," 2011 IEEE Jordan Conference on Applied Electrical Engineering and Computing Technologies (AEECT), 6-8 Dec. 2011, pp. 1-6. | [4] Hongqi Li, and Zhuang Wu, "Research on Distributed Architecture Based on SOA," 2009. ICCSN '09. International Conference on Communication Software and Networks, 27-28 Feb. 2009, pp. 670-674. | [5] J. Voos, G. Riva, Z.erbini, C. Centeno, and E. Gonzalez, "Custom HL7 V3 message provider using web services security features," 2010 Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Aug. 31 2010-Sept. 4 2010, pp. 3899-3902. | [6] Joep Perk, Guy De Backer, Helmut Gohlke, Ian Graham, Z¨ eljko Reiner, W.M. Monique Verschuren, Christian Albus, Pascale Benlian, Gudrun Boysen, Renata Cifkova, Christi Deaton, Shah Ebrahim, Miles Fisher, Giuseppe Germano, Richard Hobbs, Arno Hoes, Sehnaz Karadeniz, Alessandro Mezzani, Eva Prescott, Lars Ryden, Martin Scherer, Mikko Syva¨nne, Wilma J.M. Scholte Op Reimer, Christiaan Vrints, David Wood, Jose Luis Zamorano, Faiez Zannad, "European Guidelines on cardiovascular disease prevention in clinical practice (version 2012) ", European Heart Journal (2012) 33, 1635–1701 | [7] Jia-Ren Chang Chien and Cheng-Chi Tai, "The Design of a Portable EGG Measurement Instrument Based on a GBA Embedded System," 15-17 Dec. 2006, IEEE International Conference on Industrial Technology, 2006. ICIT 2006. | [8] D.G.Guo, Francis E.H.Tay, L.Xu, L.M.Yu, M.N.Nyan, F.W.Chong, K.L.Yap, B.Xu, "A Long-term Wearable Vital Signs Monitoring System using BSN," 3-5 Sept. 2008, 11th EUROMICRO Conference on Digital System Design Architectures, Methods and Tools, 2008. DSD '08. | |