Design of Mobile Healthcare Service with Health Records Format Evaluation

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Abstract— **This study designed an Android mobile platform to serve as a connection center for peripheral and personal health record servers, combining the frameworks of mobile health management and wireless body area networks (WBAN). The client and the healthcare server employ CCR (Continuity of Care Record) as the standard data exchange format, allowing it to work interoperability among various health information systems. We compared the performance and speeds of two formats used for CCR documents: XML and JSON converted from XML. The aim was to provide a transmission approach that makes the best use of the resources and offers a high degree of efficiency.**

Keywords— Mobile Health, WBAN, Android, CCR, Telemedicine, PHR, REST

I. Introduction

Healthcare applications have also expanded from remote (e-health) to mobile (m-health); the focuses of ubiquitous healthcare systems (u-health) and personal health solutions (p-health) are evolving toward patients' families, individuals, and wireless body area networks (WBAN) [1-2]. The main driving force behind the changes has been the use of mobile broadband and emerging healthcare devices and services for tracking human vital signs and providing interactive services. Personal Health Records (PHR)[3] should integrate personal health data from various sources (hospitals or one's home), while providing complete and accurate personal health and medical records through the internet or portable devices in compliance with security and privacy principles. Most of these records comprise the results of general physical examinations, which can be measured outside the hospital. The most frequent application is the long-term monitoring of the vital signs (weight, blood pressure, blood sugar) of chronic patients (such as diabetes and cardiovascular diseases) in the home or via WBAN during movement[4].

This study designed an Android mobile platform to serve as a connection center for vital signs monitoring peripherals and personal health record servers, combining the frameworks of mobile health management and wireless body area networks (WBAN). The proposed client and the healthcare server use continuity of care record (CCR) [5] as a data exchange standard, allowing interoperability with other health information systems. CCR is a type of personal health record (PHR). Its core dataset contains chronological health data, which can be shared among healthcare practitioners to facilitate sequential examination. CCR includes a summary of the patient's health conditions (such as patient complaints, drug use, and allergy records), insurance, advance directive, healthcare documents, and healthcare plan suggestions. Patient identification data and the purposes of CCR are also noted. CCR can be recorded, displayed, and transmitted in the forms of paper or electronic data; however, to make the most of this technology, electronic CCR must be produced in a structured electronic format to facilitate exchange among various systems.

This study adopted XML as the standard format to ensure the exchangeability of electronic CCR. We also compare the performance and speeds of two formats used for CCR documents: XML (extensible markup language) and JSON (Javascript Object and Array notation) converted from CCR XML. This study hopes to provide a transmission approach that makes the best use of the resources and offers high efficiency. For data transmission, we propose a communications framework that allows enterprises to choose between XML and JSON, according to their needs. Due to the performance restrictions of mobile devices, data exchange performance is crucial important, we compared various data parsing methods. The proposed framework is able to select the ideal data parsing method to match the needs of user devices to achieve optimal data acquisition performance.

II. Proposed System Structure

The remote healthcare service system with integrated physiological measurements comprises three frameworks: Android-based middleware, communications, and services. The structure is presented in Fig. 1. The connection center includes Android tablets and smartphones; the Android-based middleware framework receives and processes data related to vital signs from various instruments (blood pressure devices, oximeters, electrocardiogram).

The data is then transmitted in packets via 3G/WiFi. Android-based smartphones provide a user-friendly interface, which allows users to communicate (via Bluetooth) with devices that perform physiological measurement. The communication framework allows the client to communicate with the server, according to the resources available to the client. Following the selection of an ideal data acquisition method, requests for personal physiological data (in JSON or XML format) are sent to the server via the service framework based on REST-like APIs [6]. When the client submits a request through the framework, the service framework interacts with the back-end scheduling database, user profile database,

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and physiological monitoring database according to the client's access permissions and demands, while the short message server provides emergency notifications. We integrated the service framework with a website to provide a statistical graphical user interface for tracking vital signs over the long-term. For example, "other health interface service" in the figure shows how various personal healthcare systems can connect to each other via the APIs.

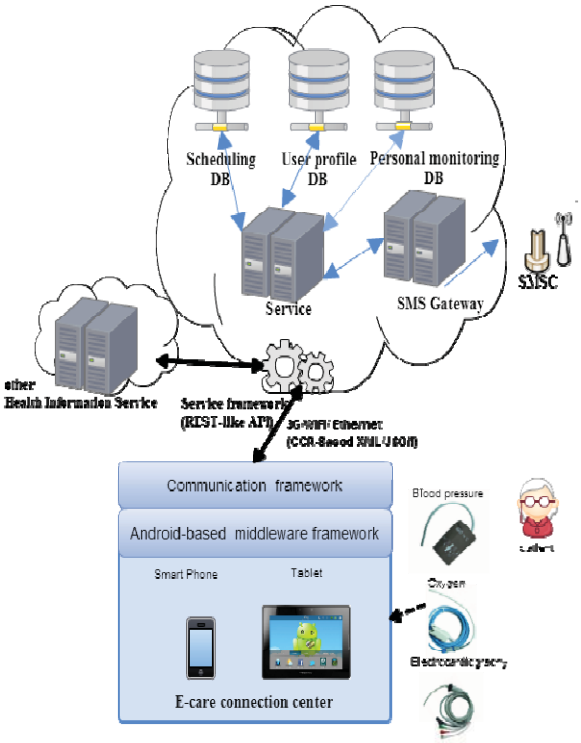

Fig. 1. Structure of Remote Healthcare Service System with Integrated Physiological Measurements.

III. Case Study on Parsing Performance of XML and JSON-based CCR

To understand the impact of XML and JSON-based CCRs, we created a CCR generator and a series of CCR file containing records with 1, 500, 1000, 2000, 5000, 10000, 20000 and 40000 vital signs objects in XML and JSON format and the data size show in Table 1. The experiments are tested at Android 4.0 Google Nexus Smartphone.

Table 1 Data size of CCR Objects

(KB)	1	500	1000	2000	5000	10000	20000	40000
XML	0.676	130	249	498	1243	2486	4970	9939
JSON	0.469	88.7	171	341	852	1703	3405	6808

A. Experimented Results

This experiment focused on the measurement of CCR parsing performance. We conducted tests on XML Document Object Model (DOM), Simple API for XML (SAX), and JSON Parser. We implemented the DOM, SAX and JSON Parser. The results have shown in Fig 2. The parsing time for SAX-based XML parser for CCR on Android smartphone is faster than JSON-based parser or DOM-based XML parser for CCR. XML DOM is much slower than the others approaches and is therefore not recommended.

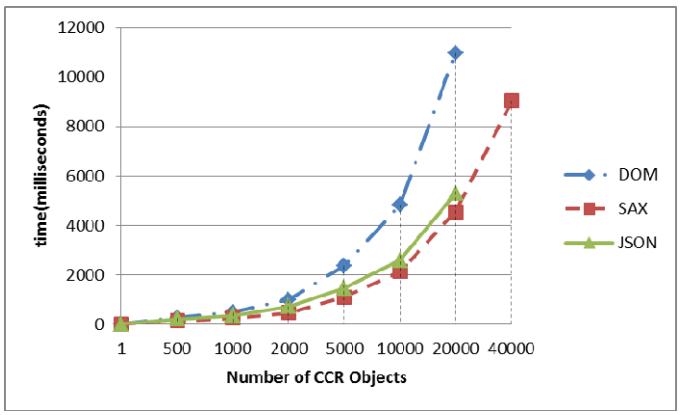

Fig. 2 Parsing Time for different parser versus number of CCR objects.

IV. Conclusions

This study designs combined the frameworks of mobile health management and WBAN to create an open Android mobile platform to serve as a connection between peripheral devices and personal health record servers. The service framework includes a self-health management reference design as well as schedule management and short messaging modules to provide healthcare management functionality, notifications, and emergency help services.

To identify the best data parsing method for the proposed structure, we compared the performance and speed of CCR in XML and JSON converted from XML. By evaluating various parsing methods and analyzing the test results, we developed a communication framework that manages and controls a range of devices to provide the most efficient data acquisition method for devices with limited resources.

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