# Poster Abstract: Exploring Cloud Services with Body Area Networks for Medical Care

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## ABSTRACT

Recent studies [1][2] use mobile phones as data aggregators of body area networks. To better support body network applications, mobile phones can also utilize cloud services. In this paper, we explore the opportunities to design and develop personal health care applications with cloud services. Specifically, relay service, rendezvous service, speech to text service, and other web services are incorporated into a medical alarm response system that we design and develop on Windows Phone 7. The proposed system architecture consists of three components: a front-end body area network that collects personal health data, a mobile app that aggregates data collected and accesses cloud, and the cloud that provides data processing, storage, and other novel services. Most of the existing alarm systems on mobile phones do not use cloud services. Our case study demonstrates rich functionalities and potentials of integrating cloud services into body area networks.

## 1. INTRODUCTION

Increasing use of smart phones and mobile handheld devices within wireless networks along with the open could computing environment offers tremendous opportunity in providing various health care solutions, for example, notifying caregivers regarding critical vital signs captured by wearable health care devices. Existing personal care systems [3][4] usually use manual user interface to collect health data and save them within closed database environment. In this work, we design and develop an emergency report system that 1) continuously collects data related to patient and stores it within a cloud database which is accessible to caregivers to diagnose critical health care problems in real-time, 2) utilizes cloud services, such as the Relay Service and Rendezvous Service provided by Microsoft Research project Hawaii [5], to propagate emergency alerts in a faster and safer manner than existing approach, and 3) easily portable to various mobile operating systems.

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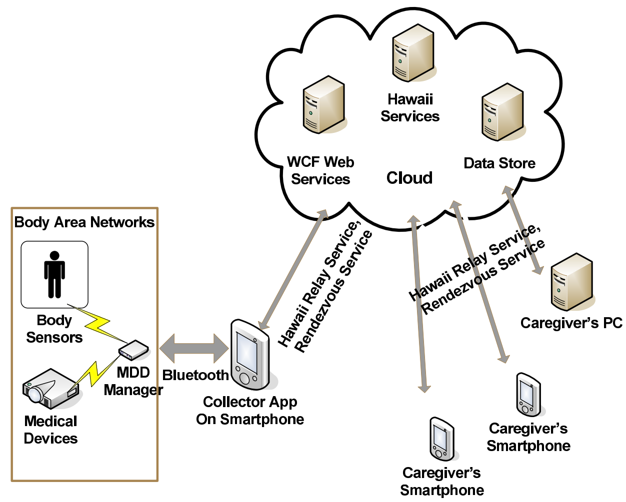


**Figure 1: System Architecture**

Figure 1 shows our system architecture. This system mainly consists of three components: a front-end body area network that collects personal health data, a mobile app that aggregates data and allows interactions with the user, and a set of cloud services including Hawaii and Window Communication Foundation (WCF) services. Specifically, Medical Device Dongle (MDD) manager collects data from wearable medical sensors or devices attached to patient [6]. Our mobile application uses Bluetooth technology to communicate with such MDD manager device. This mobile application collects the data and stores it in could using WCF Service. If collected signs indicate alarm to be generated then the mobile app will propagate alert through Relay service and Rendezvous service. The mobile application also allows users to create health report with Speech to Text Service. The mobile application is developed on a Samsung Focus phone.

Compared to existing personal health care systems, which do not utilize cloud services, our system design have several key advantages: 1) cloud provides secure storage for large amount of medical data, which is also easily accessible to caregivers; 2) cloud services can help organize users into groups based on their interests, location etc, and facilitate fast and efficient communications within groups; 3) cloud services provide user-friendly interfaces, such as speech to text service and optical to text service. These services are very helpful to patients, such as elderly people that could not operate mobile phones.

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## 2. A CASE STUDY: AN EMERGENCY REPORT SYSTEM

In this section, we use an emergency report system as a case study to demonstrate how cloud services can benefit medical care applications. The basic task of our application is to detect critical vital signs captured via various body sensors and medical devices and to send alerts to certain group of caregivers. We achieved this by using combination of Relay service and Rendezvous service.

The Relay service creates a unique identifier, named registration id, that can be used to identify each endpoint or group when transmitting and receiving messages. We use the term 'group' to indicate the group of caregivers who should receive alert messages. On startup, application will try to locate such a group, say 'cardiologists in center city' using Rendezvous service. If it cannot locate the required group, it creates a registration id. After the process of group registration, application creates end-point and registers itself to particular group using Relay service. Application running on various mobile devices uses this technique to register itself to one or more such medical care groups. Thus we created different multicast groups within our emergency report system.

The Rendezvous service allows a user to associate and look up a specified name to the registration ids which are used by the Relay service, such as the 'cardiologists in center city". Along with group registration process, on startup, application also loads specific alarm conditions, such as "early stage congestive heart failure condition" in terms of heart rate patterns, from cloud for each different kind of measurements. Simultaneously the mobile application constantly communicates to MDD manager via Bluetooth and starts collecting vital signs from wearable medical sensors. Upon receiving each vital sign, application compares it with specified patterns and if it detects that an alert should be generated then it relays alert message to related group using Relay service. Emergency report application also stores all collected signs along with its location information within cloud using database access layer. Emergency report application has the capability of notifying patient to indicate health status on a periodic basis. Patient can respond to such notification via voice, which gets converted to text format automatically using Hawaii Speech to Text service and saved in cloud. Such collected information can be used for the purpose of detail diagnose.

In our system we use Relay service as the backbone for the emergency alert notification. The Relay service provides a FIFO storage queue for each registered end point. Because of FIFO nature of the Relay service, messages can be saved and retrieved at a later point. This makes emergency report system a guaranteed system to propagate alerts over the groups of endpoints or singular end point within our medical care network.

In our system we use Rendezvous service to maintain various groups for sending alerts. Human readable name handling of Rendezvous service provides simple partitioning of different kind of emergency system groups, for example alerts related to heart conditions can be sent to only those caregivers who deal with heart problems.

WCF and Hawaii web services, hosted in cloud, are http based interfaces and hence these services could be used by any mobile platform supporting http request. In Emergency Report system entire database access layer is written using WCF web service architecture. We used ODBC as the database connectivity, which makes system to work with any kind of databases. Currently as mobile application is implemented for WP7 platform, we have used Windows Live ID with Identification service to validate user to access WCF web services.

The Speech to Text service takes a spoken phrase and returns text in English. Our application running on mobile device, periodically recommends patient/user to indicate health information. Patient may elect to interact via voice. In such instance, application uses this service to convert voice to text format and stores such text results within cloud which can used to generate detail health report.

## 3. SYSTEM IMPLEMENTATION

In this Emergency Report System, we implemented mobile application using Silverlight and C#.net on Windows Phone 7 mobile platform. Such mobile application can easily be rewritten for other mobile platforms like Android, iOS for MAC, etc. We have tried to solve major problem of providing secure, efficient, faster and scalable emergency report system which can also store medical information about patient within a web cloud. This data can be accessed on various kinds of mobile devices as well as personal computers. Our system is also capable of storing location information of the device along with the vital signs. The saved location information can also be used for the future references.

## 4. FUTURE WORK

Our current system design doesn't explore exclusive security and privacy features except standard windows live identification service. We plan to further allow users to be validated using our proprietary security access system. We also plan to design algorithms on searching for domain specific doctors and sharing data among them. We can extend our work to us with other cloud services like Optical Character Recognition in cloud. One such application would be to capture barcode of any medication which could be translated in textual name and this identified name can be used to locate detail of particular medication within could.

## 5. REFERENCES


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