Developing Mobile Systems using PalCom -- A Data Collection Example

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Abstract. We developed a mobile system for collecting and communicating heart rate data in real-time using low cost, commonly available equipment. This system could be used to monitor patients with cardiac arrhythmia over long periods of time, hopefully increasing the chance of capturing and recording an actual fibrillation, which rarely is the case today. Such recordings are useful for physicians to find the right diagnosis. We have developed the system using the PalCom middleware and report on its usefulness for providing support for this kind of applications.

Keywords: Mobile Systems, PalCom, Android, Data Collection, Heart Rate Monitoring, Cardiac Arrhythmia

1 Introduction

When constructing mobile systems there's a large portion of overhead compared to implementing the kernel of the actual problem. The overhead consists of e.g. managing networks connections, defining protocols, creating runnable applications and user interfaces, etc. These aspects are merely needed to get a fully working system around the solution to the problem itself. To decrease the amount of overhead, a middleware that offers support for these aspects can be useful. This paper demonstrates how the PalCom middleware can be used to develop a mobile system for collecting and communicating heart rate data. This concrete example demands local offline storage, permanent online storage, inter-device communication and network communication capabilities. For the proposed solution, the amount of overhead vs. the amount of work on the problem solution will be discussed.

2 Diagnosing Cardiac Arrhythmia

For people who suffer from cardiac arrhythmia, it is often difficult to establish a reliable diagnosis. Fibrillation occurs infrequently, and usually not in controlled situations. Existing portable ECG recorders are big, bulky and rarely present when fibrillation occurs, such as when sporting or during other straining activities. Physicians thus often have to rely on the patient's own recollection of

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what happened during a fibrillation. Hence, a system where a simple, inexpensive mobile devices could constantly record the heart rate of a patient, thereby capturing the fibrillations, would be very valuable. Such a system is proposed to be assembled from a commercial heart rate monitor, typically used when exercising, and a mobile phone – equipment that is light, mobile, cheap, easy to use and readily available. Using this equipment, the heart rate data of the patient could be constantly collected and transmitted directly to a database, where a physician could examine the results, in real-time or at his/her convenience.

The prototype system works as illustrated in Fig. 1.

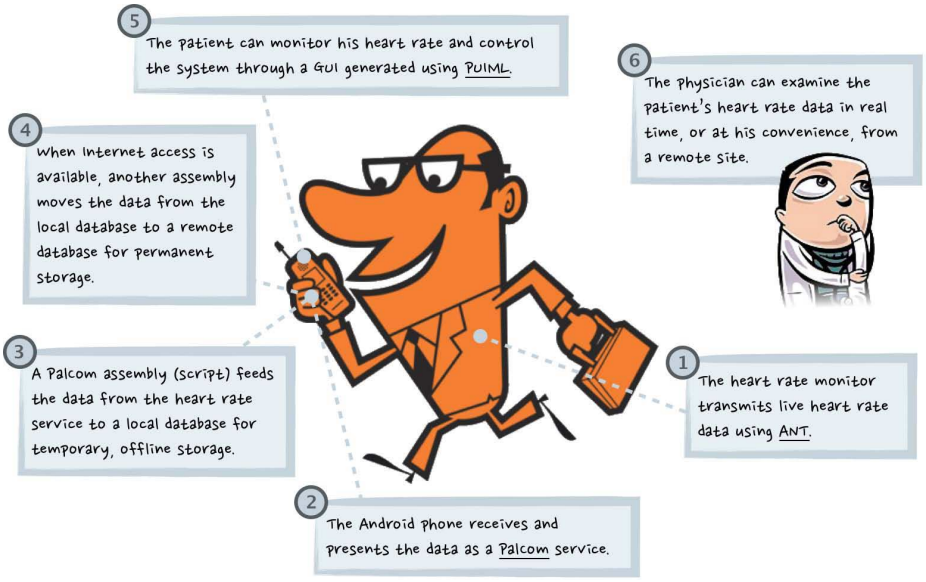

Fig. 1. System functionality overview

3 The PalCom Middleware

PalCom [1] is a middleware framework used to combine the services offered by different devices in an easy and flexible manner. By doing this, new functionality can be created by coordinating already existing services in new formations. In PalCom, all devices are represented by *PalCom devices*. Similarly, all functionality provided by such devices is presented in the form of *PalCom services*. This provides a homogeneous representation of system components, hiding complexity of systems using heterogeneous networks. Once created, these PalCom components can be used and reused in any number of solutions. PalCom components are selected and coordinated into PalCom systems by defining *PalCom*

assemblies. Assemblies have a configuration part, which defines what devices and services to include, and a coordination part, which is a simple script to define the coordinated behavior of services.

4 System Architecture

In the constructed prototype system, the patients are issued a *Garmin HRM1G* heart rate monitor (HRM) and a *Sony Ericsson Xperia X10 Mini*. Other hardware could easily be used, however since the communication between the HRM and the phone is done using the ultra-low power protocol *ANT* [2], both devices must support this protocol. Fig. 2 shows a slightly abbreviated technical overview of the prototype system.

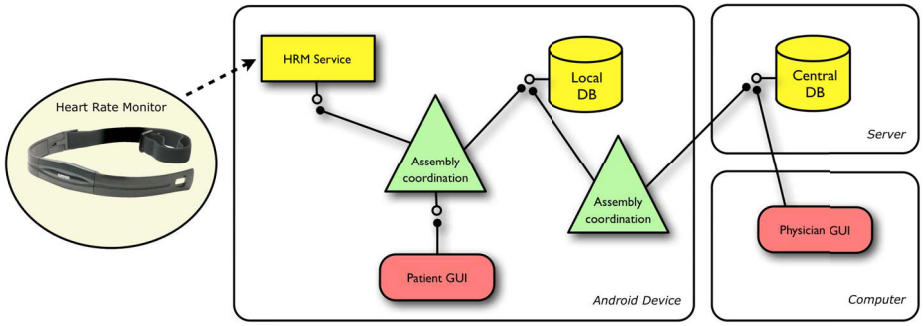

Fig. 2. Technical (PalCom) system overview

By using PalCom to develop the system, most of the overhead traditionally associated with creating a system from the ground up was avoided. In Fig. 2, the PalCom services labeled "Local DB" and "Central DB" were already existing building blocks that were reused for the system. The configuration and coordination of the system was created with little effort using the scripts of the PalCom assemblies. Note that no special work had to be carried out to handle that the system is distributed over three different sites. Using PalCom, this complexity is hidden. The graphical user interfaces (GUIs) used to control the system (labeled "Patient GUI" and "Physician GUI" in Fig. 2) were generated from descriptions written in *PUIML* [3]. The approach taken in PUIML is to visualize PalCom services based on a given description. This enables the creation of complete applications with reconfigurable PalCom GUIs, making them reusable for different systems.

5 Conclusions

The prototype system and its basic functionality is complete. The only detailed programming (in Java) needed to create this system was to make the information

provided by the HRM over ANT available as a PalCom service, a matter of some 500 lines of code[1]. With that available the system was put together using the PalCom middleware with scripted assemblies and GUIs. All the components are easy to reuse in other applications, only creating other assemblies.

6 Further Work

Further work is needed mainly in the following areas:

Battery Life Crude preliminary tests show an estimated battery life time of about 6–9 hours when the phone actively receives data from the HRM and transmits it over Wi-Fi to the central database on a per second basis. Preliminary measurements indicate that battery life should be extendable to several days by updating at a rate of every 10 seconds, which should be appropriate.

Other Middleware A discussion around how PalCom compares to other middleware, such as BizTalk [4] and Obje [5], based on the experience with presented system would be of interest.

Evaluation So far, the system has been tested exclusively on the authors. The system is to be evaluated in two steps. First, on a single technically savant person that suffers from cardiac arrhythmia, with no involvement of a physician. Second, on a select group of actual patients treated by a physician, where both the patients and the physician will be involved in the evaluation.

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[1] Calculated using "Lines of Code Counter", `http://java.net/projects/loc-counter/pages/Home` [Online; accessed 27-April-2012]