Mobile Services for a Medical Communication Center: The eSana Project

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Abstract : *Current statistics show that in Europe more than 80% of the population has a mobile phone. The popularity and place independent utilization are reasons for using these devices in the health sector. In medical environments mobile devices could transmit physiological parameters.*
This article focuses on the eSana framework. eSana is a platform that redefines the communication between a customer/patient and a Medical Communication Center (MCC) by the consequential use of a mobile device for the customer/patient part. Furthermore, eSana is service independent. This paper focuses on a service designed for diabetics.
eSana has three layers. The bottom layer defines how physiological parameters, e.g. blood pressure, blood glucose or heart rate can be transmitted from a mobile device to a medical communication center and stored there. The middle layer defines different statistical analyses of this data. The top layer enables dynamic counseling by a doctor or therapist.
In a diabetic environment eSana could be used to send a patient's blood glucose value periodically to an MCC. With eSana, a patient can get analyses of his blood glucose values by accessing a website or by receiving a message, generated by eSana, on his mobile device. Furthermore, a doctor can observe the data.

Keywords: eHealth, eSana, diabetes, mobile measuring devices.

1. Mega Trend eHealth

eHealth or electronic Health stands for the use of information and communication technology (IAC) for improving the quality and decision fundamentals, efficiency increase and regional and worldwide healthcare guaranty (Maheu, M. & Whitten, P. & Allen, A. (2001)). The use of IAC in fields like telemedicine or disease management needs a rethinking by all participants, i.e. care provider (doctors, therapists, drugstores, labs, hospitals), health insurance companies, services enquirers (patients), but, also in the public sector.

The objectives of eHealth are the optimization of the process flows in the patient care, the costs reduction, the quality and safety increase, the better integration of medical information, the gain of research base material and the promotion of interpersonal interactions. Therefore, suitable communication networks and information systems have to be developed, made available and maintained for accessing patients' medical dossiers. IAC enables an electronic health market, increases the care quality and supplies all therapy relevant information at the right time and place.

To eHealth challenges belong:
- Web based information supply and prevention;
- Informatics based process optimization;
- Electronic patients dossiers;
- Tele consultation and telemedicine;
- Disease management;
- Data protection and data security;
- Community creation.

For covering these eHealth application fields, suitable platforms have to be built and connected together.

The communication between customer and Medical Communication Centers (MCC) using mobile devices was already a topic in former projects.

The MOEBIUS project (Mobile extranet-based integrated user services) (Reichlin, S. (2003)), (Eikemeier, C. et al. (2001)) integrates doctors, patients and MCCs. The communication platform for patients was restricted to one particular device. In contrast, eSana can be used with most available mobile devices.

WellMate ™ (Brännback, M., & Söderlund, R. (1999)) was a finish project done in cooperation with Nokia. The idea of WellMate was to collect blood glucose values from diabetes patients. In contrast to eSana, these values were transmitted to a service provider using SMS.

In a project from the University of Munich (Wolf, B. & Scholz, A. & Henning, T. (2004)) a device for measuring the lung functionality was developed. This device is connected to a mobile telephone and sends the values to a server.

Vitaphone (2005) is a german company that distributes a mobile phone to be used for personal emergency calls. Additionally, the phone can record ECG's and send them to a server using the GSM network.

This article describes the eSana architecture, which permits the mobile access to medical information systems or Communication Centers. The remainder of this paper is structured as follows: The eSana layer model and the communication between client and server are presented in section 2. Section 3 illustrates a mobile application for a certain patients group – diabetics. The paper concludes with a discussion and further research directions in section 4.

2. The eSana Architecture

The eSana framework was developed as a mobile integrated solution for the communication between the health insurance company/medical Communication Center and their customers. Many health insurance companies mandate a medical communication center to act as a 24 hour medical helpdesk. If no external MCC has been mandated, the health insurance company typically has an internal department which will act as a medical helpdesk. Throughout this paper we will use the term MCC for the internal department and the independent Communication Center respectively. All customers of the health insurance company can contact the MCC, which can be done using different media. The most popular media is the phone. A person calls the MCC and asks all kinds of medical questions there. The MCC gives first medical consulting or guidance for choosing a doctor or a certain drug.

2.1 Application View in eSana

The eSana architecture extends communication by phone - interested customers use their mobile device to send and receive data automatically (or in exceptional cases also manually). The mobile device runs an application called eSanaClient. This application wraps all eSana client functionalities. Reciprocally there is an eSanaServer application, running on a server maintained by the MCC and accessible on the Internet.

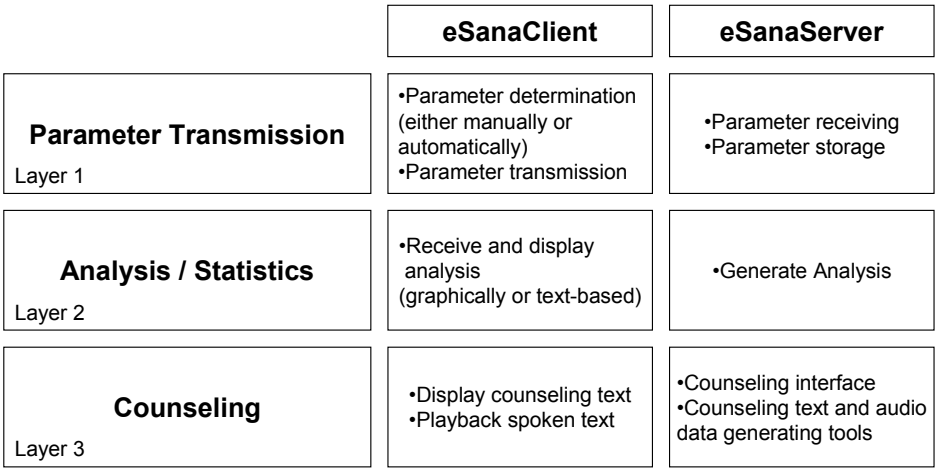

Figure 1 Layered architecture

The eSana framework is divided in three layers (cp. fig.1). On each layer, data is exchanged between the customer and the MCC.

The top layer (1) regulates the transmission of physiological parameters from the eSanaClient to the eSanaServer. Please note that eSana is not restricted to special physiological parameters, all kinds of parameters can be transmitted in this layer. The received parameters can be stored for the customer. The physiological parameters can either be transmitted from a medical device automatically to the customer's mobile device, or they can be entered manually in the eSana client. An example of a medical device is the blood pressure measuring device, which measures the patient's blood pressure and sends periodically the measured values to the mobile device (respectively eSanaClient). The eSanaClient transmits the parameters to the eSanaServer.

The middle layer (2) provides tools for analyzing the received parameters. One can get, for example, statistics (graphically or text based) from eSanaServer. Furthermore, it is possible to generate reports automatically.

The bottom layer (3) is used for customer counseling. Besides the customer, certain counsels- doctors, therapists etc. can use this layer to access certain or all received physiological parameters. The counseling can take place either after all necessary parameters are received or during recording these parameters. The counsel communicates with the customer over the already known eSanaClient/eSanaServer connection.

2.2 Profiles

eSana is suitable for many different application cases. The configuration for a case is done using so-called profiles. This article focuses on the profile for a diabetes patient. An eSana profile defines the communication between eSanaClient and eSanaServer. The following aspects are defined:

- What kind of data (for example physiological parameters) is transmitted from the eSanaClient to the eSanaServer? *For the diabetes solution, the blood glucose value is sent.*
- How long is the data stored by the eSanaServer? *The data is stored for several years because of public law conditions.*
- What kind of analysis methods exist? *Two different statistics are supported, one for the doctor, the other one for the diabetes patient (cf. section 3).*
- Who can access the data? *The data can only be accessed by the patient. However, the patient can give read access to doctors.*
- What kind of counseling possibilities should be used? *For diabetes, a small application is installed that is called whenever a new blood glucose value comes in. This application alarms if the value is in a risk area.*

From a technical point of view a profile can be described as a specific configuration of the eSana application (eSanaClient / eSanaServer). A profile is defined using an XML document and is read from the eSanaServer as well as from the eSanaClient. Currently, only one profile can be defined at the start, in the future the eSanaServer as well as the eSanaClient should be able to manage more profiles.

2.3. eSana Prototype

To further evaluate eSana, a prototype has been implemented (cf. figure 2). Both the eSanaClient and eSanaServer are implemented in Java, for the eSanaClient the Java 2 Micro Edition (J2ME) and for the eSanaServer the Java 2 Standard Edition (J2SE) is used. The web part of the eSanaServer is supported by the Apache Struts Framework (Husted, T. et al. (2003)).

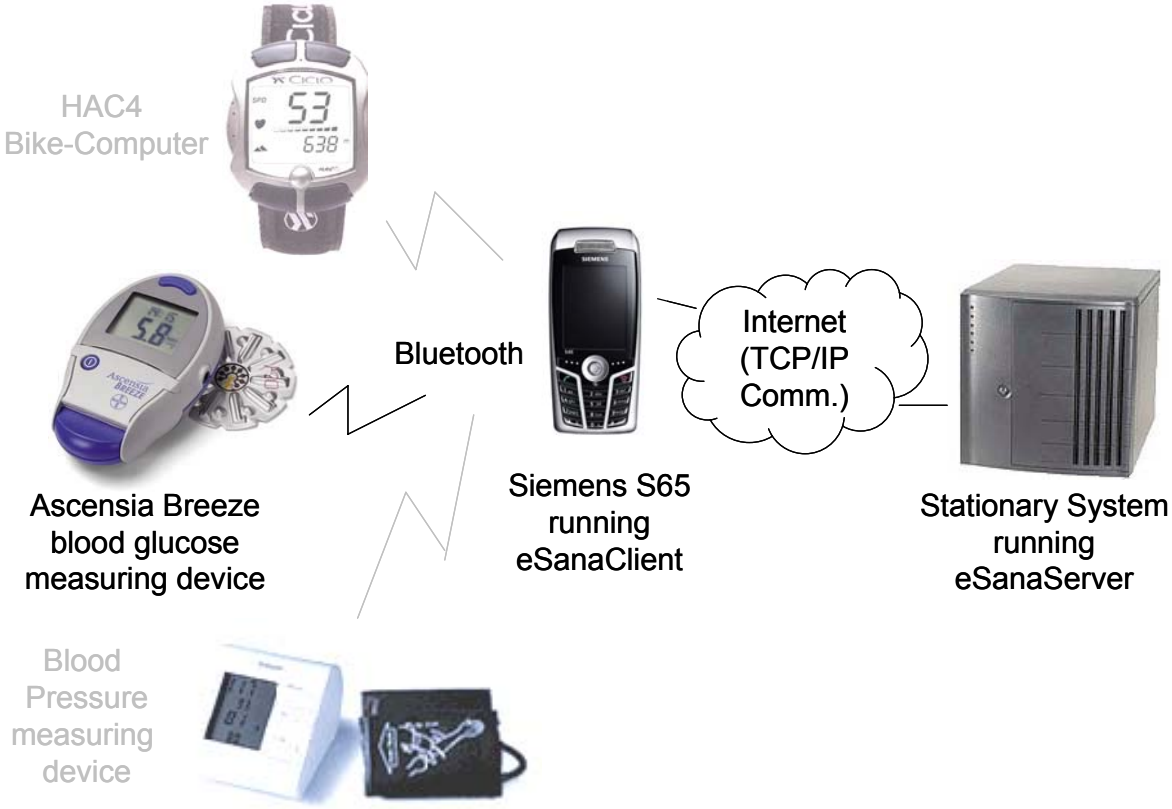

Figure 2 Devices of the eSana Prototype

With eSana, the communication between customer and MCC takes exclusively place between the eSanaClient and the eSanaServer. The communication itself is established over the Internet. eSana does not specify the connection which could be established using Wireless LAN, an Ethernet connection or the GSM/GPRS network, depending on the alternatives of the customer. For the communication the TCP/IP protocol is used. This connection has to enable authentication as well as data encryption. In version 1.0, the Mobile Information Device Profile (MIDP) supplied by J2ME does not provide the needed cryptographic methods (Knudsen, J., 2000). Therefore, the newest version 2.0 is used, which is currently only supported by a small number of mobile devices.

In the prototype the communication between the mobile device and measurement device is realized using a Bluetooth connection. Therefore, the blood glucose measurement device Ascensia Breeze was equipped with a Bluetooth adapter. Both devices allow a serial access of the stored parameter. A serial access to the mobile device can be accomplished over the Serial Port Profile (SPP). For establishing a Bluetooth connection over J2ME, Java APIs for Bluetooth Wireless Technology (JABWT), which is also available only for current devices, is used. The main advantage of eSana is the support of different scenarios which can be specified using different profiles. This is illustrated by showing other devices

like the HAC4 bike-computer or a blood pressure measuring device in figure 2, however, this paper focuses on the blood glucose measuring device for diabetes patients.

3. eSana for Diabetes Patients

One approach for improving health care of diabetics is the "health pass", which is used by many diabetics. In this pass people can log when they have made examinations. This health pass can either be in paper or in electronic form. There are several advantages when the MCC administrates an electronic health pass. Some of the advantages are:

- Data can be analyzed better and faster.
- Doctors have a better patients overlook.
- Patients can track the evolution of their diabetes parameter partially place- and time independent.

The diabetic patient still has to measure several values and later on enter or communicate them to the MCC. Medical parameter visualizations are possible only with a computer.

3.1 Parameter transmission

One possible simplification of the above statement is the use of mobile devices, which allow the measurement of several parameters and their automatic transmission to a MCC. Afterwards, the MCC can send the evolution of the parameters as well as counseling information to the mobile device of the diabetic.

Table 1 shows the parameters and how often they have to be measured by diabetics.

Daily/Weekly	Monthly/ Quarterly	Yearly
•Blood Glucose	•Weight •Blood pressure •HbA1c •Legg	•Kidney function analysis •Eye analysis •Vascular Analysis •Electrocardiogram •Triglyceride •Number of hypoglycema •Number of dayswith illness •Number of days in hospital

Table 1 Physiological parameters measured by diabetic patients

Furthermore, information like anamnesis, apoplexy, heart attack, or accompanying diseases is logged. Patients can measure parameters like weight, blood pressure or blood glucose by themselves. During the last years different products, especially for measuring blood pressure and blood glucose, appeared on the market.

Ascensia Breeze (2005) is one of the many blood glucose measuring devices available currently on the market, which is also used in the eSana prototype. Ascensia Breeze allows measuring the blood glucose with only a few blood drops. Within seconds the measured value appears on the device's display, being stored, at the same time. The measuring device has a serial interface, which enables the transmission of the measured parameters to a computer. The measured values can be analyzed by using the software "Diabass".

The presented approach has two disadvantages. The diabetic needs a personal computer where the parameters are stored. If a doctor or MCC should evaluate the data, the patient has to send them to the doctor/MCC.

The solution facilitate by eSana connects the blood glucose measuring device with the patient's mobile device. Current statistics show that in the meantime mobile devices are more widespread than stationary devices. In Germany, for example, only 57% of the families have a computer, but, on average, more than one mobile phone per family (German Federal Office for Statistics (1998 & 2003)).

3.2 Statistics

On the one hand diabetics are asked to follow a specific nutrition- and movement program, on the other hand they are asked to measure periodically certain parameters, which are affected by their nutrition and movement. With eSana, they can access this statistical analysis directly on their mobile device or using a web browser. Figure 3 shows some example data of Mr. Barney for April displayed in a web browser. He has to measure the blood glucose each day. Whenever the value is critical, a message is sent to him automatically. Additionally, these values are stored and shown in the statistic for further control.

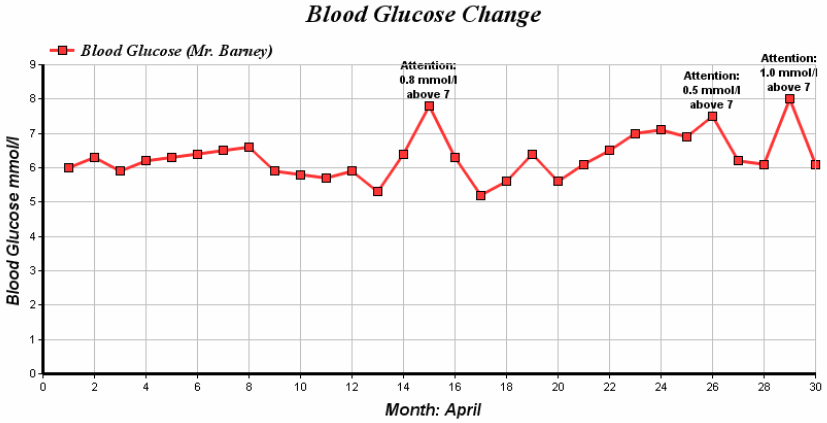

Figure 3 Blood Glucose of Mr. Barney

Doctors have to monitor the parameters of their diabetic patients permanently (cf. table 1). They should be able to recognize negligence respectively completeness of the analysis immediately and intervene in critical situations. Besides the consideration of individual values, the doctor needs aggregated perspectives for his patient collective. The overall view of his patients enables the doctor to analyze their compliance for the diabetes program. Blood glucose / blood pressure self control, diabetes trainings, nutritional consulting, and data input are therefore analyzed. Aggregated analysis can show if a new therapy represents indeed an improvement and if special examination methods improve the diagnostic investigation. With eSana, doctors can exchange results and treatments of their investigations (in consideration of data protection) and improve the medical care of their patients.

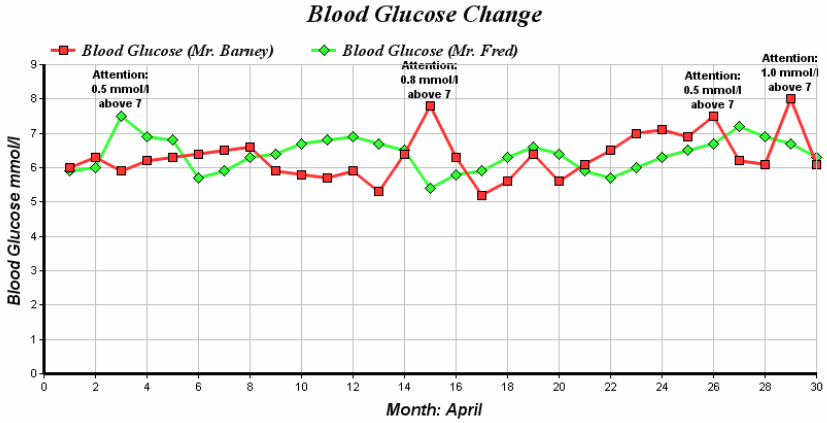

Figure 4 Blood glucose of Mr. Barney and Mr. Fred

Figure 4 shows an example statistic of Mr. Barney and Mr. Smith as seen by their doctor. Both have given read access of the parameters to the doctor. Afterwards, the doctor can see and compare the parameters. Additionally, whenever a critical value is measured, a message is also sent to the doctor.

3.3 Counseling

Besides the statistical analysis of their parameters, patients can be advised dynamically. Patients have to measure parameters periodically themselves. If they have not measured them or they have not done it

properly, they will receive a message on their mobile device. If their parameters are in a critical area they will also receive a message. The doctor in charge can advise the patient how he has to behave for getting his parameters back to normal values. For the patient this kind of medical care is often more convenient, as he does not have to visit his doctor immediately.
Other parameters, like the ophthalmic ability has to be checked by a doctor. In this case the patient could be reminded about an existing appointment.

3.4 Benefits

The diabetic as well as the doctor benefits from using eSana (cp. 3.2 & 3.3). The advantages of using eSana are summarized below:

- The doctor has a better overview of his patients.
- The doctor is able to recognize negligence respectively completeness of the analysis and can intervene in critical situations.
- The doctor can evaluate treatment methods and the compliance of his patients collective for the diabetes program.
- Health risks for the patients are diminished.
- The permanent monitoring improves the patient's feeling of safety.
- The patient doesn't have to visit the doctor for every change in his parameter value, as the doctor can advise, when necessary, the patient how to get his parameter back to normal values.
- The parameters are transmitted automatically, the patient doesn't have to enter date and time by himself.
- Typing errors are eliminated due to the automatic transmission.
- Parameter measurement has to fulfill certain conditions, like body position, rest time and alimentation before measuring. The mobile device can check some of these conditions, and if necessary the patient could be informed that the conditions are not fulfilled.

4. Outlook

While there are several approaches for particular interests groups, eSana is developed from the beginning as an integrated solution. The fact that eSana is suitable for different interest groups and different parameters, sustains the universality of eSana. A prototype of eSana is currently developed in collaboration with a medical communication center and a few health insurance companies. Conditioned by the success of this first prototype it will be decided if these services should be offered to the insurants and if the application should be customized also for other interests groups. eSana is based on current technology and works only with the newest mobile devices. As technology is constantly progressing, this restriction will not be important in the future.

The eSana architecture permits a secure communication between the mobile device and the MCC. This could be used, also, for other applications. One interesting application is the care of old or handicapped persons by using, for example, person emergency call systems- Vitaphone (2005). Such persons could get, if necessary, monitoring around the clock, without having to stay in a hospital or in the house all the time. The goal is the improvement of life quality for these persons, as they do not have to leave their familiar ambience. In contrast to present person emergency call systems, eSana would permit a bi-directional communication, which could be used also for other services.

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Bio

After finishing his PhD at the University of Zurich, Switzerland, Henrik Stormer founded the startup company eTorrent together with some colleagues. eTorrent is specialized in electronic Health applications and has a working relationship with a Suisse based medical communication center.

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