Mobile computing in medical and healthcare industry

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Abstract: We believe the specific development of applications for mobile devices is the most important issue for ensuring the integration of mobile computing within the medical industry. This must reflect the individual device design and the individual user groups.

Keywords: User focused application design, mobile and wireless computing

1 Introduction & Retrospective

The medical industry – in terms of IT and computing – never was part of the front runners in regards to patient care or clinical trials. This is partly true in both Europe and the United States. Mobile computing is no exception. The medical environment has been slow to adapt to technical progress in the IT field. In strong contrast to the overall medical improvement which in many fields are advancing with great speed – the IT usage is not regarded as a priority. The industry in general is quite fragmented and this is probably one of the main reasons. Early research institutes, Pharmacos R&D, Pharma Reps, Doctors and other medical staff and the patients – are not working in one process chain as seen in many other industries. Industries which have realized monetary benefits from using the internet and mobile computing obviously are the ones who have been setting industry standards. The automotive manufacturing and logistics are examples.

- Most efficient when orchestrated and conducted as a global overall process. Process costs may not at first glance bring tangible results for a patient, but ultimately it will.

- The big incentive for using mobile computing is the relative low costs of both hardware as well as the application development itself.

- Big Incentive $\Longrightarrow$ Question: what about workflow improvement, reduction of multiple data entry and data capture, accessibility of data independent of personal location . . .

Figure 1: Mobility vs. Functionality

2 "Tec is here – application is where?"

The technical issues should no longer be in the centre of attention. The applications are what is still missing. We have some very good examples for Mobile & Wireless applications which are already being used in the medical industry. The problem is that those applications are still rare and not integrated in the overall business process in most cases.

We will now assume that the technical infrastructure, the devices and the places of usage can host mobile computing. From here on we will focus on the functionality and display, i.e. the applications running on the devices and the user interface.

Applications are the key drivers when the technological framework is set and is working properly. Our focus group are human beings – be that patients or medical staff. As it is the case with any software, it must reflect the need of the user, be part of a business process and should be easy to use by a broad audience. Internet applications have specific guidelines and frameworks because they must reflect needs and wants of various profiles (user groups). They are used in an online environment and in many cases requires the participation of the user (interactivity). The requirements for mobile applications are somewhat different but not more complicated. It simply demands that certain interface issues of design and workflow are taken into consideration.

If you can succeed in taking the question of Mobile computing from being a technical question into being a question of communication, and focus on the possible applications, chances are that medical staff and patients alike will accept and use mobile computing. In the same manner as we perceive a television set where we put relatively little emphasis on the hardware and much more on the numbers of stations and programs that can be seen.

A similar approach is when you discuss Mobile computing – you must focus on the audience.

3 Application development to reflect and support the business process

Before designing a specific application it is important to draw up the existing business process to the largest possible extent. Then you can address the layout of the adequate means of integrating mobile computing as a general communication layer. In all cases it is of essential value that the process is not fragmented and that there are no data transfer interruptions (i.e. pc to paper to pc). We often see good individual applications that unfortunately loose relevance because they are fragmented or the electronic process is cut (Airport handling applications i.e. electronic check-in counters are often cited as examples)

4 Cross industry experience: Benchmarks eBanking and eLogistics

Two industries that have taken on the internet as an integrated part of business process are the banking- and the logistic companies. Banks – both retail and private banking have to a great extent taken the online banking as a competitive advantage to attract customers and to retain customers. Cost reduction is the main driver since the process costs (especially in retail banking) is significant. This is achieved by outsourcing process elements to the customer. Now that most banks and insurance companies offer a wide variety of online banking solutions, the Graphical User Interface (GUI) and the applications are becoming increasingly important because the customers have a much lower loyalty towards the bank when using the online communication means. If a customer feels unhappy with the current online baking offer, he/she will not hesitate to change the bank. Thus a number of mobile applications are now available and are seen as a means to differentiate from competitors. In general we can say that the design and the user friendliness are the most important factors. Thequality of the online offering is part of customer retainment. The logistics industry has taken the extensive use of mobile computing because it offers great cost reduction compared to previous process layouts. A customer can require services either via internet, telephone or fax. From then on, the order is monitored and processed electronically. The driver will carry a mobile device incl. a barcode scanner – the delivery form and the receiving customer will be handed over a copy of the shipping notice printed out on a mobile device, sign off the receiving on the touch screen display using an electronic signature. The business process is in a large sense based around mobile computing – both on and offline.

It may be that the medical industry is not going to undertake major reengineering projects to integrate new methods of computing. However learning from other business fields, we clearly can state that the more the mobile computing is integrated within the overall business processes, the more cost-and quality effects will result. It is obvious that the existing processes in many medical areas are pre-qualified to embrace mobile computing.
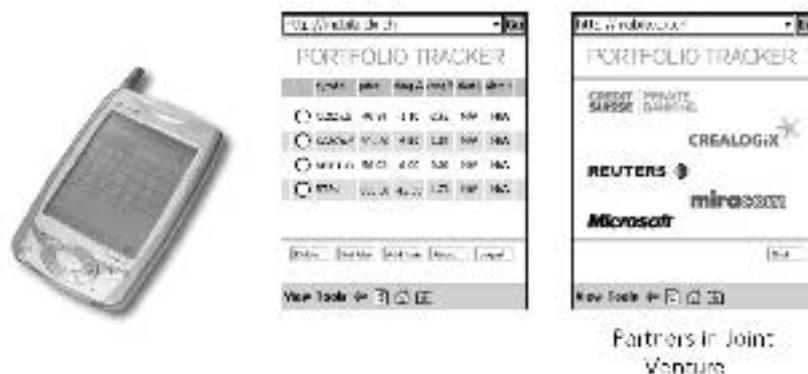
Figure 2: Example "Wireless Portfolio Alert"

5 Two examples of Pocket PC applications

The most recent mobile and wireless business applications realised were using a device that combines a Pocket PC with a cellphone. This is often referred to as a Smartphone.

The first example given is a mobile internet application, an online means of monitoring your investment portfolio anytime -anywhere. It is called "Wireless Portfolio Alert". It basically interacts with the settings done initially on your workstation PC, listing all your investment titles and setting limits for min and max values when you would like to be notified in the event of those settings being reached. An automatically generated alert mail or SMS will notify you about this event. In addition you can receive information regarding the individual titles, interact in selling and buying of any titles or contact your broker if required via browser, mail or telephone. It is an integrated part of an existing internet application – essentially because investors want to be constantly informed about their portfolio and using this mobile application they have the same quality of information and interactiveness to react at any given time regardless if they are in the office or travelling. This especially is valid for investors who trade with short term products and on several stock markets. (multi continent trading – timezones)

The second application allows you to access your company intranet from a remote mobile device. It allows you to access Key Performance Indicators (KPI) so that those employees who require constant updates on key figures can have access to internal data. This is done in a secure environment and guarantees that no unauthorized person can access the intranet. It is especially important for sales people who can enter- or receive data required to perform daily work more efficiently. "Mobile KPI" is an application that combines the enterprise ERP system with mobile internet and computing. The type of data process (in this case sales data) is very flexible and can be implemented in almost any environment that requires mobile access to existing data sources and applications – typically available in an internal computer network. This example very well can be adopted to a medical environment – both hospital internal as well as patient monitoring and patient-input.
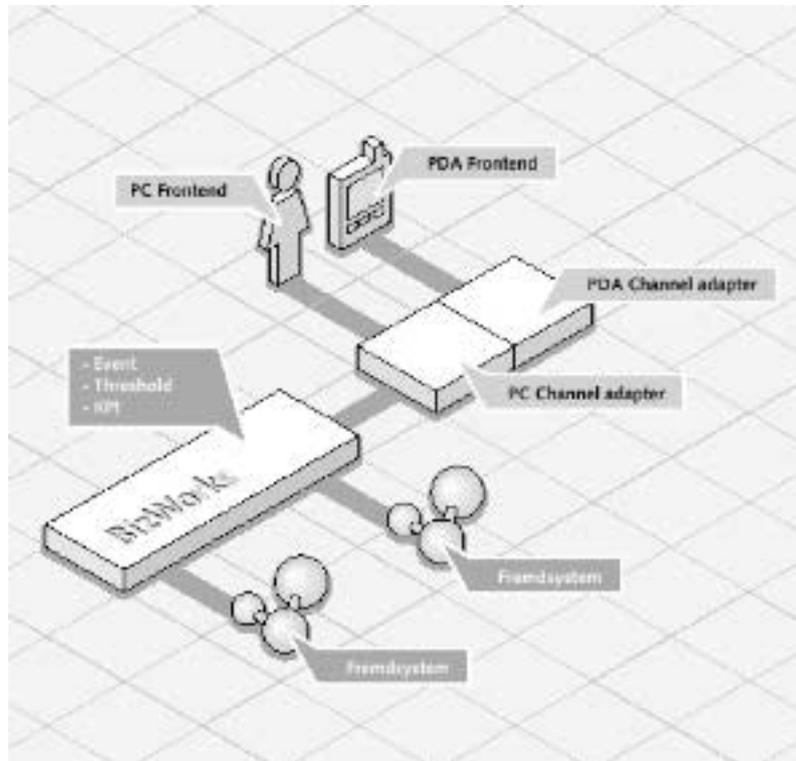
Figure 3: Example Wireless KPI Architecture

This Architecture as shown in the wireless KPI example (multidevice enterprise portal, personalisation, access restriction, data security) can easily be adopted in a medical environment as displayed in figure 5.

6   Example from Japan's "i-mode"

Almost 30 million Japanese consumers use "i-mode" the NTT DoCoMo platform for mobile phone communications that was introduced only 3 years ago in a country which has one of the lowest internet usage rates of all developed countries. What are the reasons for this extraordinary success? You may argue that the Japanese in general are keen to move in groups, and surely the NTT DoCoMo corporation has proven one of the largest business success in the past 30 years. It has revolutionized the mobile phone market in Japan and Korea and has now arrived in Europe (Germany's e-plus and Holland's KPN). It is a leisure oriented service using a special mobile phone on a proprietary network. Over the i-mode platform users get easy access to more than 40,000 Internet sites, as well as
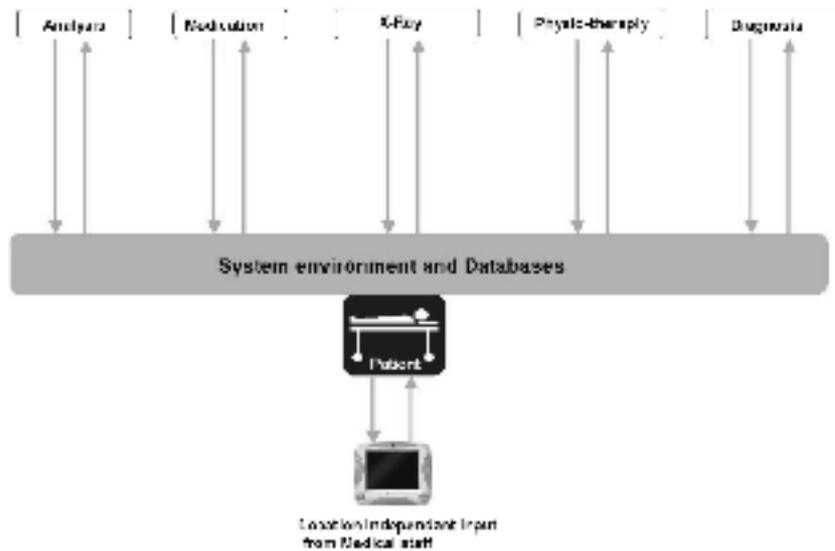
Figure 4: Example: Webtablets

specialized services such as e-mail, online shopping and banking, ticket reservations, and restaurant advice. It is completely service oriented and no technical emphasis is required from the user. It combines regular mobile telephone calls with internet applications. The bandwidth used is similar to the GMS bandwidth and is also complimented with UMTS (FOMA) areas (Tokyo). It has proven that the individual user is in average spending almost 50% more on mobile telephone services compared to other mobile operators. The basic principle is: stay focused on applications (services) and the people will use it. The reason why we use "i-mode" as an example is because of its User-focus – ensuring high quality applications – easy to use – and not focusing on the technical aspects apart from Device design.

We agree that the European market and consumers in general are different to the Japanese consumers and the B2B approach is not very outspoken. However we believe the philosophy of "i-mode" is impressive and can be used as a benchmark for mobile computing.

7   pdate on the technology progress 2002 - "GPRS is here"

The 2.5 and 3G mobile phones and Smartphones as well as PDAs with GSM modules, are on the consumer market as of today. Throughout the European Union, the GPRS network service is available. It offers a (theoretic) bandwidth up to 100 Kbps – and even though at this moment the throughput is somewhat lower, it is still a lot faster than GSM. The next step to follow is UMTS – probably available at full scale as of year 2005. The devices

and networks are available but in a strong contrast, hardly any private or corporate service applications are being offered. We believe this will take well over the next 12 months before a larger scale of such services will be standard. The big advantage of GPRS is "always online" and the possibility to have both simultaneously: voice communication and data transfer. In the future the devices will be able to support the appropriate communication technology, depending where the user is. (WLAN, bluetooth, GSM, UMTS, wired networks).

8 SMS / EMS and MMS is also part of mobile computing...patients interactive

The European mobile telephone market has seen the SMS as big revenue source; mainly due to the simplicity of the use and the cheap cost per unit. For mobile computing needs, the next steps – EMS (Enhanced Messaging Service) and MMS (Multimedia Messaging Service) are available or will become available in the year 2002 across Europe. Both EMS and MMS require a larger bandwidth - GPRS can support this. In basic terms, it offers the possibility to transfer larger text messages, to include pictures, attachments, audio and video. This especially is relevant for patient-frequent involvement (Disease Management, Clinical Trials, patient data input etc) The other advantage of this technical development is the very low cost implicated to install such platforms.

9 General benefits and disadvantages of mobile computing

Benefits:

- One of the big advantages is the "always with you". The fast processing of data offers a unique and very valuable asset for the medical industry. The interactiveness of patients is given new perspectives since it doesn't require big infrastructure on either side

- Applications in general are simple and require no or little technical knowledge for user groups

- Application development for mobile solutions can be realized within modest budgets

Con's :

- It can also mean more technical emphasis which can be a stress factor for patients as well as medical staff. The input of data needs to be secured and stored. The infrastructure may not be able to offer the same standards as with wired infrastructures.

- The radiation issue is still unclear and needs to be clarified. The industry overall must agree to a certain industry standard – this is not the case at the moment.

10 User Profiles – how to define needs and Design Guidelines for GUI

As with all application design, the essential is to define in as much detail the individual user needs that are using the application. This means both socio-demographics, education, experience with Internet- and IT in general, motivation to use mobile computing, motivation for self-benefit, urgency etc. It requires the detail description. This needs a great deal of attention to past experiences and making use of early stage usability testing for internet application development. It is very important to understand the psychological aspects that may interfere and to understand the level of motivation for each user group to use the mobile computing facilities in order to ensure a high compliance rate.

The applications must be designed for the actual end-device, meaning the overall size of device, weight, display size, colour monitor or black & white etc. All general ergonomic considerations must be defined and described prior to application development.

The User groups should be classed in as many categories as meaningful (but no more than necessary) and during the development phase, rapid prototyping and clickable prototypes should be made available for test groups.

11 Specific areas of mobile Computing in the Medical Industry

From an IT company's perspective, we believe the potential for cost reduction through the implementation of mobile and wireleless computing as an integrated part of the overall processes is significantly higher than in most other industries. The majority of the users are by definition not allocated to a set workstation but in the contrary are more or less constantly moving around in the building complex. Thus until today Information technology proccesses could only be used in a suboptimal way.

Mobile computing in a medical environment can be used for example:

- Clinical Trials

- Hospital Process (Doctors, nurses, laboratories, patients)

- Medical Doctors Office (Patient Diaries, prescriptions t drugstores etc)

- Pharmacos to Medical Staff & Patients

- Disease Management

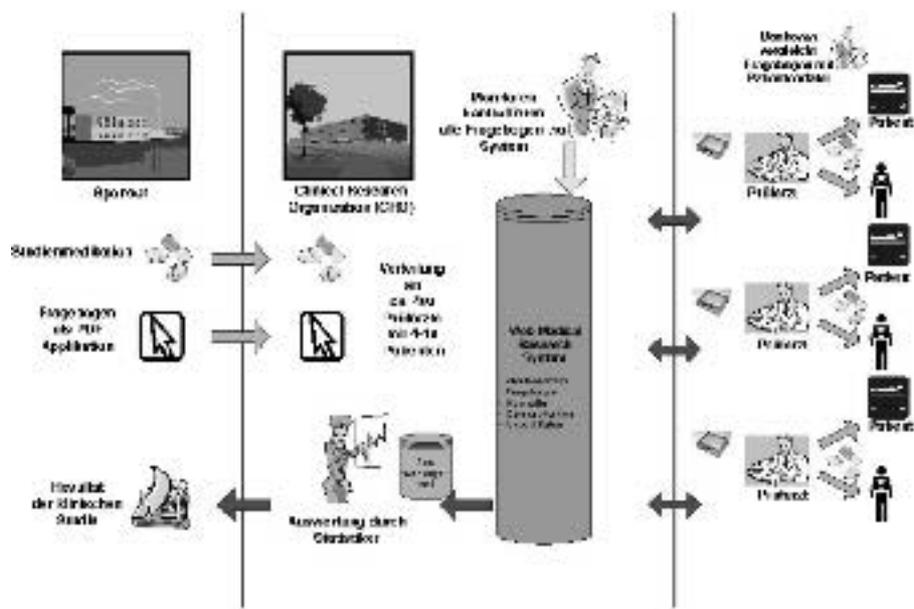- TeleMedicine

The following figure is just a theoretical example of a process layout:

Figure 5: Clinical Research