DESIGNING E-EDUCATION SUPPORTS IN E-HEALTH BASED SYSTEMS

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ABSTRACT

The inadequate availability of medical information has often made health care services in many developing countries cumbersome with enormous paper work, waste of life, time and resources, long queues, and ineffective treatment procedures.

The use of mobile technology devices such as Personal Digital Assistants, Cell phone, Tablet PCs etc for health care delivery promises a revolution in modern health care. However, applications that provide access to real-time patients and research information at the point-of-care via mobile devices are at best in their low stage of adoption across the health sector.

In this paper, the experience gained in designing mobile health care applications is used to proffer e-Education functionalities in the design of healthcare systems to enhance their acceptance in the medical domain. The application discussed uses, the Unified Modelling Language, mobile, and Java-based technologies for its development. The application provides a real-time access to medical information at the points of health-care delivery within health care centres.

Keywords: e-Education, Communications, Hospital, Mobile, Information

INTRODUCTION

E-Health is the use of advanced communications technologies, such as the Internet, portable, wireless and other sophisticated devices to support health care delivery and education (Ikhu-Omoregbe et al, 2007, Ray Jones et al, 2005, Gunther Eysenbach, 2001). E-Health entails a fundamental redesign of health care processes based on the use and integration of electronic communication at all levels.

A benefit of e-Health is that patients in one country can seek treatment and other services from other countries with their patient records accessed electronically. A patient with his medical information moving electronically via mobile technology is empowered to play active role in the decision making process during treatment since decisions are made in a shared manner.

Treatment processes in care centres are facilitated with the introduction of operations support systems (OSS).

E-Health based OSS is essentially designed to automate manual health care processes, making the operations of health care practitioners more error-free and efficient. OSS solutions for e-Health take advantage of state-of-the-art information technology to address health care enterprise-wide needs and requirements to reduce costs, provide reliable, flexible, mobile, timely, and secure health care delivery to patients by health care providers, centres or practitioners (Linhoff M, 2002). An e-Health system with e-Education functionalities provides (WHO 2007).

> Information for health promotion and awareness, medical education, health and biomedical research, evidence-based medicine, and e-learning;
> Information for health information system (disease surveillance, health statistics, management information system, financial, logistics, monitoring and evaluation);
> Information for health care delivery: diagnostics, treatment, consultation (telemedicine applications) and electronic patient records; and
> A platform to render health related services to patient such as medical diagnosis, patient care, after care interactions, training, etc.

The use of mobile technology devices such as PDAs, cell phones, laptops, etc for health care (mobile health care) (Jakob Nielsen, 2005, Olubukola D. A., and Ayeni J.O.A., 2005) delivery promises a revolution to benefit modern health care.

With mobile technologies, providers have the ability to instantly access patients' information and other research information to ensure that they are current.

Physicians with up to date information, stand to make more accurate prescription decisions, thereby reducing harmful drug interactions. In addition to enhancing quality of patient care, e-Health technology, through the elimination of redundant paperwork, also facilitates more efficient and effective delivery of patient care.

E-Health programmes encompass applications that directly provide education for physicians to support prevention of illnesses and diseases, patient diagnosis, patient management and care, etc. These applications include tele-consultations, tele-referrals, forward-storage concepts (e.g., tele-radiology and tele-prescriptions), and electronic patient records.

Where new functionalities such as e-Education applications are introduced or made to integrate with legacy health care system, the behaviour of the entire systems must conform to the specified requirements of the resulting system.

Formal approaches are used to verify the conformance (Slyvanus Agbonifoh Ehikioya, 1997) aspect of an e-Health system to ensure it has the potential to improve the efficiency of health care delivery.

Wireless LANs
WLANs allow greater flexibility and portability for health care practitioners and service providers than do traditional wired local area networks (LAN).

WLAN connects computers and other components to the network using an access point device and medical practitioners to move freely within the cell with their laptop or other network device.

Access point cells can be linked together to allow users to even "roam" within a building or between buildings as in Figure: 1.
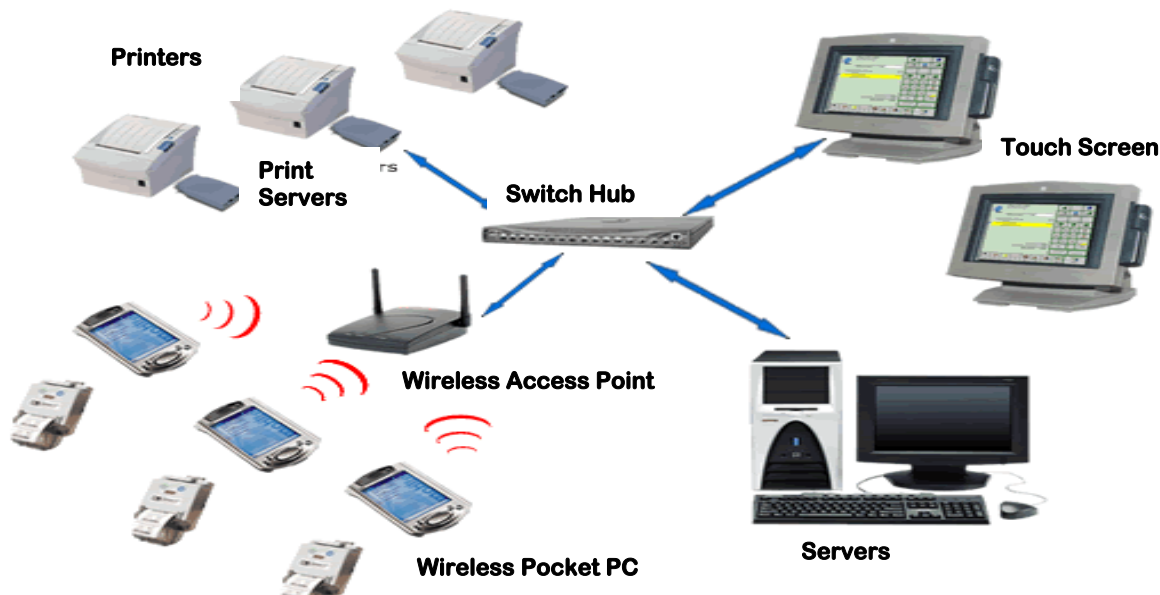
Printers

Print Servers

Touch Screen

Switch Hub

Wireless Access Point

Servers

Wireless Pocket PC

Figure: 1
**Wireless Network Devices in a Health Care Centre**

Standards and Interoperability in E-Health Systems
A major challenge being currently addressed in the development and deployment of e-Health application is that of increasing the interoperability of health care application to allow easy capture, retrieval prepossessing and exchange of information amongst various systems (Michael L. Popovich and Todd Wtkins, 2006). The use of standards have been found relevant in the exchanges of health records, transfer of laboratory results, transfer of prescription information, communication between medical devices, classification of diseases, and in the storage and exchange of medical images. Some standards that seek to address interoperability issues in health care; SNOMED CT, logical observation identifiers Names and Codes (LOINC), Health level seven (HL7), CENTC / 251, and Standard for International classification of diseases (ICD), Digital Imaging and Communications in Medicine (DICOM).

MODELLING AND DESIGN

In this section, the Unified Modelling Language (UML) is used to capture and model some of the functionalities in the application. The UML is a visual language that provides a means to visualize, construct and document the artefacts of software systems (Simeon Bennett et al, 2005). In order to provide effective health care education, the activities of teams of health care professionals have to be coordinated through well-designed formal processes that are centred on the needs of patients (WHO, 2007). The cooperation between the different personnel is captured in the collaboration diagram in Figure: 2.

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Each personnel commit his investigation for the education of the next physician a patient moves from one stage of treatment to the other within the hospital setting.
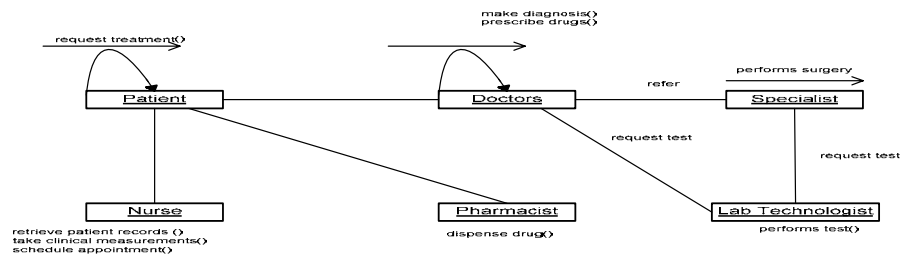
Figure: 2
Collaboration Diagram

Design Architecture

In health care centres, there are high levels of mobility for medical and support staff who demand access to the same information whether they are mobile or at their workstation. The need for workflow efficiency is the main motivation for the proposed architecture. A multi-tier, client-server architecture is proposed and depicted in Figure: 3.
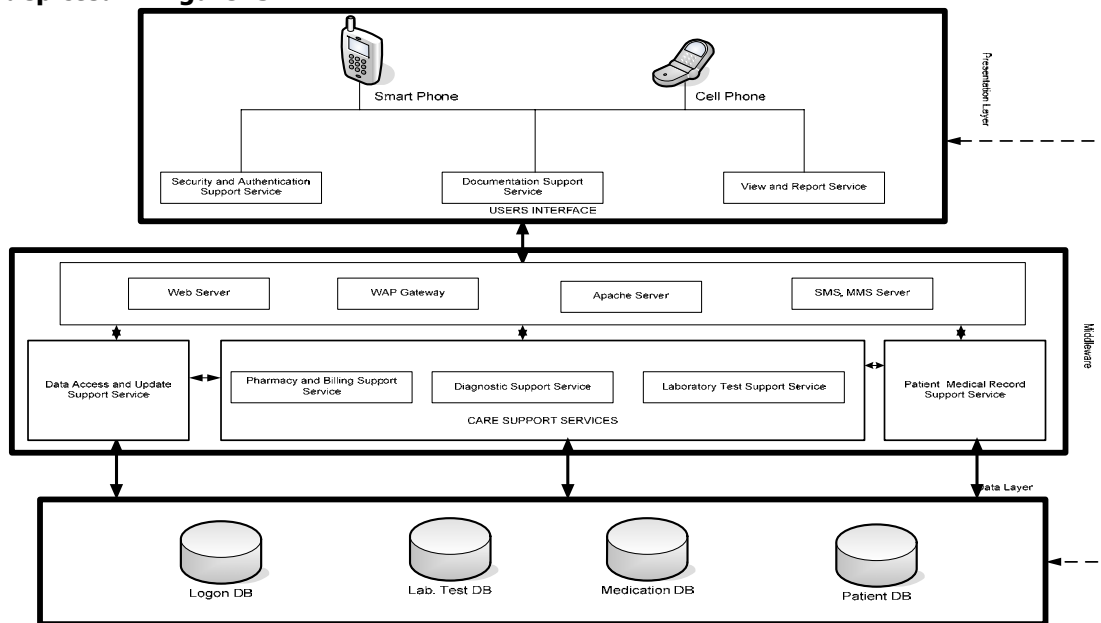
Figure: 3
Software Architecture for the Application

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The client has as its component the Security and Authentication Support Service (SASS), Documentation Support Service (DSS) and the View and Report Service (VRS). These provide an interface for the middle layer and the data layer.

Medical information is not stored on the mobile devices due to resource constraints associated with hand-held devices. Currently, server side-processing solutions offer the best alternative in most dynamic situations because they carter for the limited memory and processing power of many mobile devices (Mark Ridgeway, 2002).

It is important that any mobile access to the e-Health enterprise application be strictly controlled and regulated. The architecture is secure and uses some form of role-based access control and database-enabled authorization that integrate user's identity and role to gain access to the system.

The architecture's security is further enhanced by services such as encryption and certificate management supported by the Internet and the wireless application protocols.

The middle-tier contains most of the application logic and translates clients' requests into database queries and also translates query results to client devices. The applications supported by this middle-tier are Data Access and Update Support Service (DAUSS), Patient Medical Record Support Service (PMRSS) and the core e-Health support application which consist of the Diagnostic Support Service (DSS), Pharmacy and Billing Support Services (PBSS) as well as and the Laboratory Test Support Service (LTSS). The supports provided are intended to provide the physicians with adequate information to aid their services.

Physicians access the application from various handheld devices within the hospital. The application user's interface allows users to access the required medical information. The database server provides data services and data base management system function.

The Open Data Base Connectivity (ODBC) is used to support data logic resulting from database queries. The application enables authorised medical personnel access to the database from the point-of- care within the hospital.

IMPLEMENTATION

The prototype application was implemented and tested on a client-server architecture separated by a mobile network. The server application, developed in Java, was deployed on an Apache Server running on a Windows Operating System. Java was used for the application development to ensure its portability across various platforms. The client application accesses the server application via a windows CE micro browser on a PDA.

The design of WML decks required special considerations due to the resource constraints associated with mobile devices.

The application starts with WML cards that introduce the user to the support services integrated into the application. After a deck has been downloaded, a copy of it is cached in the mobile device for some time depending on the system's configuration.

Java Server Pages were used in addition to WML so as to add interactive functionality to the static WML pages by providing access to an MS Access database through ODBC-JDBC Bridge.

Openwave V7 Simulator provided a cost effective platform for testing the application at the development stage (being free downloadable software on the Internet). The application was deployed on an O_2 Xda Mini S PDA running Windows Mobile 5.0 operating system.

To facilitate the efficient and effective mobile health care delivery and education, it is essential to provide the functionality which directly supports the user in their preferred way of performing their task. Figure 4 shows the task and corresponding information that are required by the physicians.

Figure: 4
O_2 Xda Mini S running the Doctor's Information Module

The interface provides a doctor's module and a module for the pharmacist that allows for exchange and viewing of information related to patients' diagnosis and therapy. The information is recorded and transmitted via a mobile device to the central server.

CONCLUSION

This paper has practically demonstrated the feasibility of deploying mobile health care application on mobile devices such as mobile phones and PDA in enhancing the effectiveness of health care professionals in care centres.
The research provides a case study in the learning and transferring of skills in the design and development of software for mobile systems with education functionalities in the health care domain.

This is a unique innovation in the health care domain where the availability, timeliness and correctness of medical information are paramount to health care practitioners and service providers in the treatment of a patient.

The application when deployed would ensure live savings by enabling access to patient information via handheld devices within the hospital environment. This will eliminate medical errors usually resulting from enormous paper work associated with most treatment procedures in any typical hospital in developing countries of the world.

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