Proceedings of the 5th WSEAS Int. Conf. on MULTIMEDIA, INTERNET AND VIDEO TECHNOLOGIES, Corfu, Greece, August 17-19, 2005 (pp186-191)

A Web based Telemedicine Portal for centralized access to Patient Health Records

G.TRIANTAFYLLOU[1], G.KOYTELAKIS[1], C. BOUKOUVALAS[2], G. MANDELLOS[1], M. KOUKIAS[1], D. LYMPEROPOULOS[1]

[1]Wire Communication Lab, Electrical & Computer Engineering Dept.,
University of Patras, GREECE

[2]OTE S.A. (Greek PNO),Research & Development Dept, Athens, Greece

Abstract: Despite telemedicine's applications evolution to cover a wide area of users' needs, data centralization is not achieved yet. Also, access to patient data from any remote location, through a secure environment, is necessary to achieve remote data handling and doctor's collaboration. A remote access has been implemented through a Portal using only web modules, which do not require the users do meet any special requirements. Through an integrated environment, which is fully customized to each user's requirements, we provide doctors with the ability to organize their registered patients in an electronic manner, and civilians with the option of viewing their personal medical data from anywhere. Furthermore, an extra interface facilitates doctors' collaboration through secure communication channels and hence allowing them to view a patient's medical records. Java technology is used to satisfy design considerations and security issues concerning medical secret policy.

Key-Words: - Web access, Portal, Telemedicine, Health Record, Remote Access, Internet Technologies

1 Introduction

Telematics has evolved to such an extent during the recent years, that more and more sectors are being supported by state of the art technologies. A special category of these sectors is the health care industry, involving individual medical specialists, hospitals willing to organize their patients' records in an electronic manner and citizens themselves willing to gain access to their personal medical data [1], [2].

In order to satisfy these needs, telemedicine services have been widely developed in recent years [3]. The great advantage of such services is evident not only in distributed geographical areas, where many citizens are in need of expert help, but also in cases, where only novice doctors exist. Thus, a Telematics-telemedicine system is required, in order to assist such personnel in decision-making [4]. These systems offer communication channels between doctors and facilitate the transfer of important medical data. Using such a system and based on transferred medical evidence, any medical expert might provide a second, more accurate opinion, in order to help a colleague who is practicing in a rural area. Teleconsultation is also possible through services offered to doctors, providing audio and video communication, [5] in order to have an actual view of the patient status and imminent response in advising the appropriate treatment [6].

Another important request of health care professionals is the centralization of medical data in such a way that its accessibility on a wider scale is ensured [7]. This purpose is not always served by various installed applications, as each one of them addresses a specific need [8] and organizes data in a single health center or hospital. The need for optimal data organization becomes more compulsory in the course of time, as citizens' mobility is growing bigger and expert health care services are required in all areas. The related need of a centralized Patient Heath Record (PHR) requires medical data to be concentrated in a manner that it is accessible through a web interface from physicians and citizens as well. It would be also desirable to provide to citizens the ability of authorizing any physician to view their medical data [9].

In this paper, a *web portal* is presented, addressing most of these needs. By the term *Portal*, a site on the Internet is specified through which, access to various services and content is possible [9], [10]. Exploiting portal technologies and their consequent capabilities, we tried to concentrate several important services and make them available to health care professionals through a single gate. Implementation in a web manner of functionalities such as access to centralized data for any concerned specialist or civilian and doctors' collaboration was the main aspect of this research.

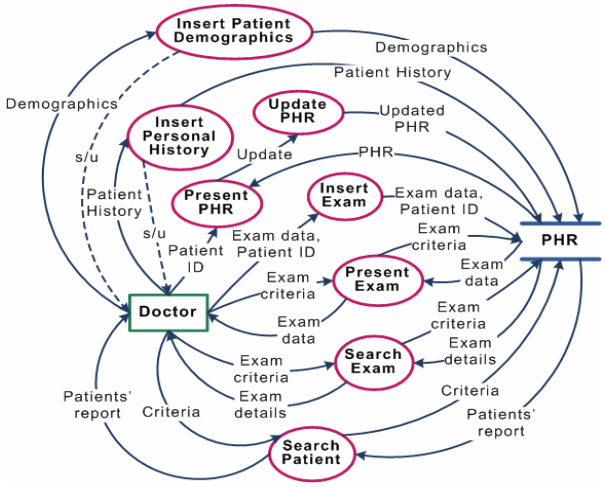

Fig. 1: Patients' - Exams' Registration

This paper is an evolution of the services analyzed and developed during previous research and described in [3].

2 Services

The proposed portal is structured both horizontally and vertically. Content useful to different types of users is added in the horizontal way, accessible through a user-friendly interface with emphasis on easy navigation. Furthermore, services answering to most of the requirements, any professional or consumer of health care services would be likely to ask for, are supported in the vertical direction. Three basic categories of services exist, each one of them appealing to a different category (subset) of potential users or user needs. *Doctor's office organization*, *Patient's access to personal data* and *Doctors' collaboration* form the range of implemented functionalities, covering most of the above user requirements in a practical, yet organized and sophisticated manner.

2.1 Doctor's office organization

A basic and diachronic requirement of any professional of the health care industry is to keep accurate records of their patients' personal data, files, visits and exams. Even while computerization offers a solution on that issue, data keeping was always restricted within office or hospital limits [11]. As a result of this, working away from one's specific professional space is not possible at the time. Our portal, offers access from any place without any special requirement on the equipment used to gain access to one's *virtual office*. A simple computer with any web browser and with no other specific software would be enough to access the portal' s pages, organizing the doctor's files and patients' records.

Using this accommodation, a professional of health care industry, might register in detail all his patients and their demographics. As depicted in Fig. 1, all records are kept in an organized manner and any search activity is facilitated by an appropriate interface, based on the desired criteria, making retrieval easy and accurate. A full inspection of all patients being treated by a specific physician is also possible, substituting for a full search inside the whole "office" organization structure and presentation of the PHR is achieved.

Moreover, the physician has the ability of entering data concerning his patient's history. An accommodated set of historical data is covered, giving the ability to keep track of events concerning allergies, lifestyle and personal medical history. In that term, the physician is capable of registering elements, referring to all current habitudes and/or diseases affecting the patient in question. These data are electronically kept in the portal's database. As a result of that, data retrieval is possible at any moment, with the additional capability of modifying it. Thus, data is kept in up to date status and is accurate to use in order to assist the professional in diagnosis making.

An additional option of registering the medical exams for each person being treated is offered to the doctor, resulting in a fully electronic organization of data. As depicted in Figure 1, insertion is possible based only on the Patient Identification Number (PatID), so that exams are related to the person in question. Viewing inserted exams is possible thanks to the appropriate retrieval mechanism, also based on the PatID.

Seven types of clinical exams are supported, offering a vast selection of laboratory tests to be inserted after being conducted on the patient and thus help the doctor to continuously monitor him in the course of time. The proposed portal supports the storage of exam types requiring multimedia data, such as images and videos data types. The physician is able to check back at already stored exams, cross reference between old and new values and monitor in that way the patient's progress and advice on the appropriate medical treatment and according prescriptions.

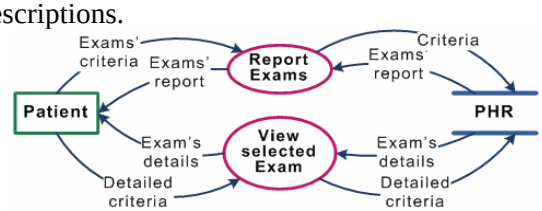

Fig. 2: Patient's access to PHR

2.2 Patient's access to personal data

The usual way to keep record of one's past medical history and visits to any doctor is the personal health care book, inside which all past actions are written. However, carrying this book is always necessary in order to visit a doctor or any organized health center or public hospital. What is more important, most exams are only accessible through the hospital organization in which they were conducted. As far as the rest of the exams are concerned, they are usually given to the patient himself to hold. Therefore, storage of medical exams is neither safe nor concentrated.

The portal design, reserves a special role for citizens themselves, in order to provide access to their PHR including personal History Data and Exams [12]. The user–patient has the ability to access remotely his personal medical data, which has been already inserted by a physician treating him. User's access is realised through a web interface, which guarantees for immediate access from any place without any special software or other equipment apart from a computer with any browser. Communication through a Secure Socket Layer (SSL) in combination with a personal password secure the whole process, satisfying the citizen's need for private data keeping without worrying about intruding in one's PHR.

As shown in Fig. 2, the ability of viewing the exams performed is offered to the citizen, after entering the system. The whole process is based on the submission of the PatID, which is automatically recognized by the system after user's log in. An underlying process, which is "transparent" to the user, is responsible of relating the patient's username to the PatID. In those terms, after successful connection to the Portal's pages, the system supplies the PatID to the PHR module, and an exams' report is provided to the user. The report includes all exams conducted on this patient, inserted by any doctor treating him. The citizen has the option of selecting a specific exam and then view it's details, in the same way this would be possible if the exams had been given to him in paper.

It becomes obvious that centralization of exams is achieved through Portal's database. The user – patient has the important benefit of keeping his medical exams in a common database, with constant remote access, avoiding the danger of data/exams loss in the same time [13]. The user has also the ability to show all personal data and/or exams to any doctor he desires. Web access makes possible either printing the exam and presenting it to any doctor, or even accessing the PHR from any place, i.e. the doctor's office and showing all personal data to him. Thus, an expertise doctor might provide an extra opinion on the results of any performed exam and on the overall health state.

2.3 Doctors' collaboration

Collaboration between doctors and teleconsultation is not very easy, nor supported by existing systems [9], [10], [12]. A non-expert doctor located in a remote environment requiring the opinion of a more expert physician does not always have the means to perform this. The same applies for doctors within urban areas, wishing to collaborate, exchange experiences in their science field and consult one another. Several times, an exam has to be performed more than once due to rules restricting access to it from outside the hospital where it was originally conducted.

The Portal's web pages retain a process for doctors to exchange opinions about their patients, while providing the essential details to their colleagues to facilitate consultation. This process, called *incident* gives to any doctor the option to create a subset of a patient's exams and ask for a second opinion. He is able to form an incident by selecting any exams that concern the specific patient and attach them to the incident. He also has the option to comment on these exams, describe the patient's status and ask for a consultation on a specific issue. Finally, an option to select any of the doctors collaborating on the same Portal is offered to the user, in order to choose for the *receiver* of the incident.

As far as the receiver is concerned, he is notified upon his next logon to the Portal's pages about any incidents that require to be diagnosed. The ability to view the sender's comments and questions, as well as all attached patient exams is offered. Patient's demographics and all other personal data are not displayed to the receiver doctor, satisfying the need of patient privacy. Finally, the receiver has the capability to submit his own comments and/or answers on sender's questions. The incident is sent back to the sender who is in turn signaled from the system that the incident has been diagnosed.

This teleconsultation method has the advantage of being applicable through the same interface that realizes *office organization*. A different web page, with a structure similar to a mailbox is provided to the doctors in order to manage their "sent" and "received" incidents or "compose" new ones. Consultation is performed with full access to any related data and a small "conversation" among doctors is enforced and realized through the

appropriate interface, in order to provide for knowledge exchange. Additionally, the purpose of advising non-expertise doctors in rural areas is realized, within a web application, easy to access from any remote environment, without using specialized equipment.

3 System analysis

The portal's structure is based on Oracle's three-tier architecture. User access is achieved in three separate stages, each one of them, taking care of requirements such as user access, authentication, security, retrieval mechanisms, and data storage. This structure follows the general model of a multi-layer, distributed application, allowing for various segments of the application to be executed in different devices. Such devices or machines are the servers used in order to implement this architecture. Containers existing in the middle-tier, i.e. pre-defined runtime environments, allow for each service to function properly. The same containers are responsible for correct creation of the service during development.

The first tier consists of the databases, containing user data and metadata important for system's operation. The user is not in direct contact with the data storage level. It is located in the first tier, so that any user has to retrieve the required data, through an appropriate module of the second tier. This is one of the methods used to preserve data-security and integrity. Despite this fact, the end-user has no knowledge of underlying processes cooperating in order to render requested data. Actually, many database entities interact with middle-tier processes in order to perform the transaction management and serve requests from each user site domain. [14]. These processes take place in a way "transparent" to the final user.

The second or middle tier includes system modules implementing pre-defined applications or web services to be offered to the end user. In this layer, request's processing takes place, referring to process requests that have been made by the client. Access to the database layer, or even data modification might be necessary, in order to fulfill such a Processing request.

The third tier is the client tier, including all kinds of browsers, web services and back office applications. Clients on this tier send requests to the second tier, using the appropriate protocols. The front-end interface of the application appears on this tier, providing the end-user with all necessary information to accomplish the desired tasks.

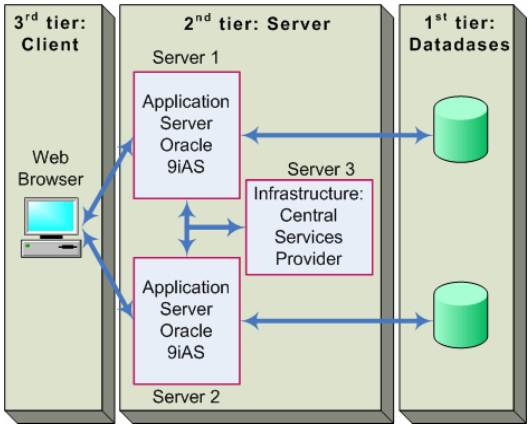

Fig. 3: The Three-Tier architecture

This three-tier architecture, shown in Fig. 3, combined with a J2EE platform offers various advantages. For example the flexible security model, in association with a simplified architecture and escalation of data management processes, offers an application customizable to user needs. This emphasis on security, acting together with the integration of existent telemedicine systems, results in web-oriented applications qualifying for most user needs especially in this area, which is sensitive due to personal health matters.

A web-oriented application consists of a browser in the client tier, presenting a web page to the user. This web page is designed using Java Server Pages (JSP) technology. The user's preferences are transmitted to the middle-tier, through SSL protocol. On the second layer, a container is responsible to translate user's requests, accomplish all logical processes, fetch data from the database and present them to the user. During these processes, the contribution of Servlets is very important. The role assigned to them, is that of acquiring user demands, asking for the requested data types from the first tier (database) and presenting them while forming the data in the appropriate manner.

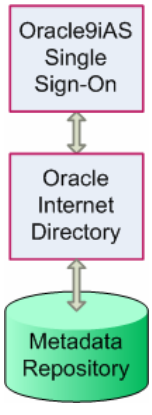

Fig. 4: SSO structure

Finally, as depicted in Fig. 4 a very important element of the architecture is the Single Sign On (SSO) Server in association with Oracle Internet Directory (OID). When a user logs in to the system, a cross-reference procedure with OID takes place. The user already registered to OID is authorized to continue navigation inside the Portal's pages. A subsequent process of association with SSO results in the user gaining access to all relevant services. In this way, underlying processes act in a way that is not noticeable by the user, as for example when a user-patient is logged in to the system and automatically gains access to view his exams.

4 Conclusions

As presented in this paper, a web portal has been developed, answering to some concurrent requirements of the health care industry and professionals. In this implementation, we tried to concentrate most of the medical data to a central data store in order to provide solutions for all affiliated individuals of this area. One of the main purposes of this Portal is to ensure access from any place, using only web modules, so that no special requirements are set up for users. In these terms, this portal is a web application, which supports remote collaboration of users on the purpose of a total benefit of distributed telemedicine applications.

In that way, an integrated environment is implemented, through which all users have access to centralized, personal data. Using this application, access to medical data is done through a web interface, which is fully customized to each user's requirements and needs. An important module that is implemented in terms of the current application is the PHR. The purpose of this module is to keep the medical data of the patient, concentrated in a central database, through which, user's access will be possible from any distributed environment. Access to that module is provided to both doctors and civilians, in order to accomplish several actions while interacting with the PHR. Such actions are data retrieval, modification and authorisation of other users to view data.

Overall the developed application satisfies the needs of *Doctor's office organization*, *Patient's access to personal data*, and *Doctors' collaboration*. Office Organization is implemented by providing to the physician the capability to register electronically his patients as well as their history and exams. Patient's access to personal data consists of ensuring to each civilian the ability to view all his past exams in a secure way. Finally, Doctors' Collaboration is realized while providing an environment for doctors to exchange data without endangering the civilians' personal data and with special care not to break the medical secret policy.

The Java-based structure of the Portal, relying on Oracle technology guarantees for accurate performance, in combination with flexible and functional interface.

References

[1] K. Siau, 'Health Care Informatics', *IEEE Transactions on Information Technology in Biomedicine*, vol.7, No.1, March 2003

[2] G. Wallace, 'Information technology and Telemedicine', *CMAJ*, September 18, 2001; 156 (6), pp 777-779

[3] E. Karavatselou, G. Economou, C. Chassomeris, V. Danelli, D. Lymberopoulos, 'OTE-TS- A New Value-Added Telematics Service for Telemedicine Applications', *IEEE Transactions on Information Technology in Biomedicine*, vol.5, No.3, pp 210-224, September 2001

[4] L. Makris, I. Kamilatos, E. V. Kopsascheilis, M. G. Strintzis, 'Teleworks: A CSCW Application for Remote Medical Diagnosis Support and Teleconsultation', *IEEE Transactions on Information Technology in Biomedicine*, vol.2, No.2, pp 62-72, June 1998

[5] I. Suzuki, K. Yamada, T. Yamakawa, M Hashiba, K. Akazawa, 'Delivery of medical multimedia contents through the TCP/IP network using RealSystem', *Computer Methods and Programs in Biomedicine, Elsevier Science*, vol 70 (2003) pp 253-258, 2003

[6] D. C. Chou, A. Y. Chou, 'Healthcare information portal: a web technology for the healthcare community', *Technology in Society, Elsevier Science*, vol 24(2002), pp 317-330, 2002

[7] M. Y. Sung, M. S. Kim, E. J. Kim J. H. Yoo, M. Sung, 'CoMed: a real time collaborative medicine system', *International Journal of Medical Informatics, Elsevier Science*, vol 57 (2000), pp 117-126, 2000

[8] H. Zeng, D. Fei, C. Fu, K. Kraft, 'Internet (WWW) based system of ultrasonic image processing tools for remote image analysis', *Computer Methods and Programs in Biomedicine, Elsevier Science*, vol 71 (2003) pp 235-241, 2003

[9] M. Shepherd, D. Zitner, C. Watters, 'Medical Portals: Web-Based Access to Medical Information', *33rd Hawaii International Conference on System Sciences, IEEE*, 2000

[10] G. Matsopoulos, V. Kouloulias, P. Asvestas, N. Mouravliansky, K. Delibasis, D. Demetriades,

'MITIS: a WWW-based medical system for managing and processing gynecological-obstetrical-radiological data', *Computer Methods and Programs in Biomedicine, Elsevier Science*, vol 76, pp 53-71, 2004

[11] G. Economou, D. Lymberopoulos, E. Karavatselou, C. Chassomeris, 'A New Concept Toward Computer-Aided Medical Diagnosis-A Prototype Implementation Addressing Pulmonary Diseases', *IEEE Transactions on Information Technology in Biomedicine*, vol.5, No.1, pp 55-66, March 2001

[12] R. Bellazzi, S. Montani, A. Riva, M. Stefanelli, 'Web-based telemedicine systems for home-care: technical issues and experiences', *Computer Methods and Programs in Biomedicine, Elsevier Science*, vol 64 (2001), pp 175-187, 2001

[13] C. Lau, S. Churchill, J. Kim, F. A. Matsen, Y. Kim, 'Asynchronous Web-Based Patient-Centered Home Telemedicine System', *IEEE Transactions on Biomedical Engineering*, vol.49, No.12, pp 1452-1462, December 2002

[14] L. Kolovou, G. Triantafyllou, C. Chassomeris, E. Karavatselou, D. Lymberopoulos, 'TM-Provider: A new Communicatory Model for Telemedicine Services Support' *26th Annual International Conference IEEE Engineering in Medicine and Biology Society (EMBS)*, September 1-5, 2004, San Fransisco, California

[15] C. Lin, J. Duann, C. Liu, H. Chen, J. Su, 'A Unified Multimedia Database System to Support Telemedicine', *IEEE Transactions on Information Technology in Biomedicine*, vol.2, No.3, pp 183-191, September 1998