Jerzy BŁASZCZYŃSKI [*], Michał KOSIEDOWSKI [^], Cezary MAZUREK [^], Roman SŁOWIŃSKI [*], Krzysztof SŁOWIŃSKI [+], Maciej STROIŃSKI [^], Szymon WILK [*]

TELEMEDICAL PORTAL 'TELEMEDYCYNAWIELKOPOLSKA'

Telemedycyna Wielkopolska is an initiative executed since mid-2005 by Poznan Supercomputing and Networking Center, Poznan University of Technology and Poznan University of Medical Sciences. Its goal is to create a system of telemedical services for the regional healthcare in Wielkopolska to improve the quality and safety of the medical services that are provided to the patients in the region. There are to main conditions to start the development of new telemedical services: broadband network connectivity and the maturity of medical community and its willingness to deploy new model of services. In Wielkopolska region both these conditions have been fulfilled and therefore the pilot project for building telemedical portal was launched. As a pilot deployment environment the domain of surgery has been chosen to show the capabilities of the developed telemedical services in practice. Telemedycyna Wielkopolska aims to construct the following set of telemedical services: teleconsultansions, reference case registry, medical teleeducation and clinical decision support. In the paper we present the architecture of the portal environment and services already being developed.

1. INTRODUCTION

'Telemedycyna Wielkopolska' is an initiative started by three academic and research organisations in Poznań which attempts to design, develop and deploy a system for the support of the day-to-day healthcare in the region of Wielkopolska. University of Medical Sciences in Poznań, Poznań University of Technology and Poznań Supercomputing and Networking Center aim to utilise the opportunities created by the PIONIER optical network [PIONIER] and build a range of advanced distributed telemedical services enabled through a web portal interface.

In this paper we present results of our first efforts aiming at creation of a regional telemedicine system in Wielkopolska. First, in section 2, we present the motivation that led us to formulate the project goals. Section 3 describes the architecture foreseen for the 'Telemedycyna Wielkopolska' system and its planned functionality. In section 4, we discuss the results of the development conducted to date and draw the plans for the future. Finally, in section 5, we reference some related activities in the areas concerned.

[*] Poznań University of Technology

[^] Poznań Supercomputing and Networking Center, ul. Noskowskiego 12/14, 61-704 Poznań

[+] University of Medical Sciences, Poznań

[*] Poznań University of Technology

2. MOTIVATION

The dynamic development of information technologies (IT) which is visible in recent years influences changes in the organization of work in almost every sphere of our life. The emergent IT tools enable an access to information resources and services to broad groups of users. Specific type of these solutions, where the new medical services take an advantage of networking technologies, are broadly understood as telemedicine services. The development and the deployment of telemedicine services brings new dimension to many medical specialities and at the same time provides profits such as an increased quality of medical services, an efficient time allocation of highly specialized medical personel, a reduction of general costs of medical processes, etc.

The development of telemedicine is higly depended on the level of IT infrastructure, mainly broadband networking. In Poland this condition is completely satisfied through Polish Optical Internet PIONIER – the national research and education network, which connects 21 optical metropolitan area networks. This infrastructure allows to build telemedical systems in our country. In Poznan as well as in the Wielkopolska region the whole medical community is looking for new solutions in telemedicine area and is ready to apply them in the practice. On the second hand the high level of broadband networking gives the chance to connect most hospitals in our region to research network. The fulfillment of these two conditions was the reason for starting up in 2005 the project "Telemedycyna Wielkopolska".

3. ARCHITECTURE

As it was discussed in the previous section, 'Telemedycyna Wielkopolska' is built to enable various advanced network services for the everyday use in medical practice. To this end the opportunities created by the existence of the PIONIER optical network are planned to be vastly exploited through the integration of services that require broadband network connection. These services include multimedia content streaming, videoconferencing, distance learning, and transmission of medical images and digital publications. Thanks to linking the hospitals in the region together it is now possible to provide a bandwidth demanding services integrated into the novel telemedical system for support of the regional healthcare.

The above-listed services are the core services of the 'Telemedycyna Wielkopolska' system. On top of these services specialised, novel telemedical services are being designed and enabled via a range of end-user applications. These services are aimed to utilise the functionality of the core services and fulfil the chosen application scenarios as required by the medical community. The architecture of the 'Telemedycyna Wielkopolska' system (Fig. 1), has been drawn upon the well-established solutions known from the grid. The primary concept adapted from the grid world is the introduction of the service provider layer grouping the high-level services that expose their functionality under the Web Services interfaces which can be easily utilised by the heterogeneous user applications [GSP1, GSP2, GSP3]. Other grid technologies used in the construction of the system of heterogeneous distributed telemedical services include the grid data management mechanisms [DMS], Grid Security Infrastructure [GSI], Grid Authorisation Service and Grid Notification Service [NOT], and GridSphere Portal Framework [GSPHERE].
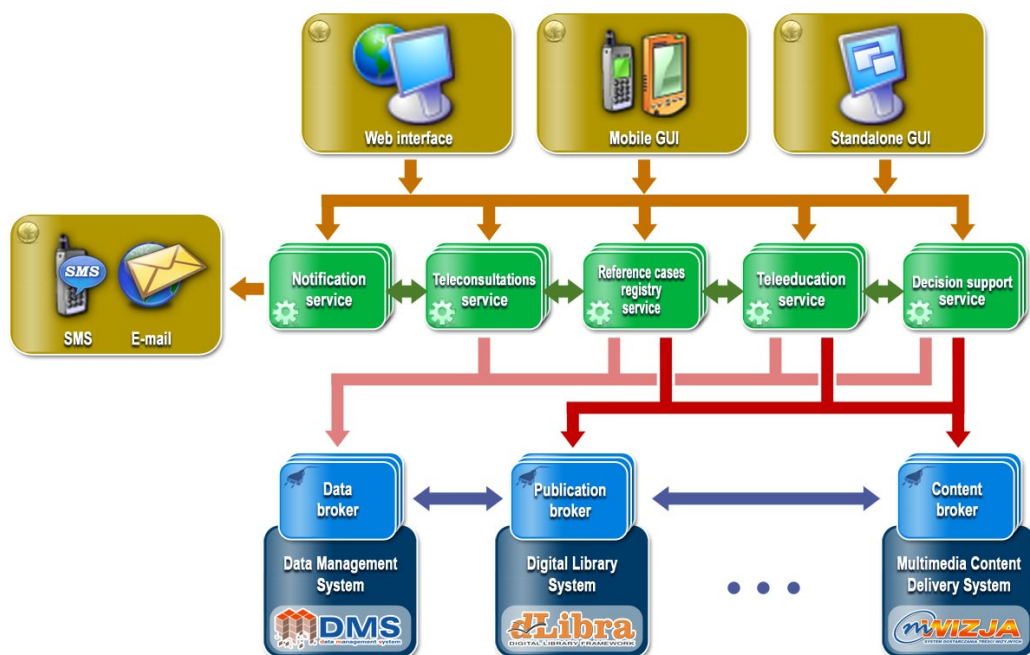
Fig.1 The architecture of the 'Telemedycyna Wielkopolska' portal

The mechanisms offered by the grid technologies and the functionality delivered by the core services, such as the Data Management System, the Digital Library System [DLIBRA] or the Multimedia Content Delivery System [ITVP] are planned for utilisation within four high-level telemedical services. These services are the Teleconsultations Service, the Reference Cases Registry Service, the Teleeducation Service and the Decision Support Service. The planned scope of these services is described in the next four subsections.

3.1. TELECONSULTATIONS SERVICE

Teleconsultations Service is about to support the specialized remote consultations for the hard medical cases that are encountered in regional hospitals and that need to be consulted remotely with experts in a specialised clinic. The cases that are considered for the Teleconsultation Service are those in which the patient is in a stable state, not requiring fast emergency help. The service will allow the doctors at local hospitals to start asynchronous conversations with the specialists assigned to solve the submitted problem. The conversations are planned to be based on the exchange of digital messages containing the results of examinations performed by the doctors and advices or detailed questions of the specialists. The conversations may last for several cycles. Each message by either party of the conversation will be followed by an SMS and/or email notification sent to the other party. The specialists will be assigned to consult the submitted cases based on the duty schedule stored in the service database. In case a deeper specialisation is required for a particular consulted case the system will offer the assigned specialist an opportunity to redirect the case to another expert, more suitable for the ongoing consultation. It is also envisaged that the teleconference connections between the parties will be enabled for use within the service.

3.2. REFERENCE CASES REGISTRY SERVICE

Reference Cases Registry Service is aimed to manage and provide a database of specially interesting cases that illustrate the procedures to undertake in similar cases found by doctors in their everyday work. This registry will be available for use within all the other telemedical services: it will serve as a source of references provided in the specialists' answers in the Teleconsultations Service, as the knowledge base in the Decision Support Service and as the educative resource in the Teleeducation Service. The reference cases registry will be organised with reflection to the existing medical domains and will allow flexible definition of the metadata for each of the domains. Each reference case will contain the results of examinations required for the given case, including the image examinations. It will also include the results of the patient state evaluation performed with the use of the standardised scales of patient state evaluation.

3.3. TELEEDUCATION SERVICE

The primary objective of the Teleeducation Service is to allow the medical personnel to constantly widen their knowledge and thus improve the overall quality of the regional healthcare. Other user group that might be interested in utilisation of this service are the students of relevant medical and nursery schools. The Teleeducation Service will create a structure over and will manage the educative resources offered by the underlying core services that is by the Digital Library System and by the Multimedia Content Delivery Service, and by the Reference Case Registry Service. In addition to passive access to the collected medical knowledge, it is also planned to enable some videoconferencing scenarios within the service to allow the users for on-line meetings with educators and other experts.

3.4. DECISION SUPPORT SERVICE

Decision Support Service will work in two modes: the assisting mode and the learning mode. In the assisting mode it will be coupled with the remaining services in order to offer additional functionalities and intelligent assistance. All other services (Teleconsultations, Reference Case Registry and Teleeducation) will use an advanced search mechanism that will allow users to look for cases similar or linked to the currently viewed, or processed. Searching for similar information will go beyond simple matching pieces of information with well defined structure (e.g., results of examinations) but it will also apply domain knowledge to evaluate similarity between cases and to search for similarity in multimedia information (with special focus on images). Decision Support Service will also offer diagnostic and management support for Teleconsultations Service – on the basis of available information characterizing the current case it will provide hints and suggestions for both parties participating in the consultation varying from simple alerts and reminders to possible management plans. In the learning mode, Decision Support Service will analyze data collected by other services (mainly Teleconsultation Service or Reference Cases Registry Service) in order to discover and update clinical knowledge that will be used in the assisting mode. Thus, the service will be able to self-improve and to accumulate new knowledge during the lifetime of the portal..

4. FUTURE WORK

The 'Telemedycyna Wielkopolska' project started last year and is currently financed from the own sources by the project consortium. To date the first prototype of the Teleconsultations Service has been developed, successfully deployed and demonstrated during a meeting with the representatives of the regional and national healthcare system and hospitals held in November in Poznań. The prototype allows to perform a consultation within one cycle of doctor-specialist message exchange with submission of image examination results enabled and notifications sent to the participating persons. It does not allow to redirect the consulted case to another specialist. The prototype of the service has been enabled with the 'Telemedycyna Wielkopolska' web portal through a specialised portlet (Fig. 2).

Fig.2 Teleconsultations Service within the 'Telemedycyna Wielkopolska' portal

Currently, the project works focus on the construction of the Reference Case Registry, deployment of the 'Telemedycyna Wielkopolska' digital library using the dLibra framework and extending the Teleconsultations Service with further elements of the planned functionality. Other works include full enabling of the grid security model with GAS and GSI mechanisms within the telemedical portal environment and a move from the Sun's Portal Server 6.0 to the GridSphere open source portal framework. Further on, the remaining services are planned for design and implementation. The work is also envisaged at the administration level where engagement of a wider part of the regional healthcare community is required for the success of the initiative.

Our experience with MET – mobile clinical decision support systems for emergency triage [MET] emphasizes the importance of providing services (not limited to decision support) to the point of care so they are made available at the bedside. Therefore, we plan to deploy

Teleconsultations Service onto mobile platforms (e.g., tablet PCs) and if it is accepted in practice, to proceed on the moblile platforms with other services provided by the portal.

5. RELATED WORK

Telemedicine is an area in which research and development are widely undertaken throughout the world. Many interesting projects lead to the creation of solutions that enable to support the healthcare systems and increase the quality of patient treatment. In Europe, this subject has been financed through the Framework Programmes. One of such projects, Healthware, aims to develop telemedical services utilising satellite and digital television technologies (DVB-RCS: Digital Video Broadcasting - Return Channel by Satellite) [HEALTHWARE]. Other like Mermoth [MERMOTH] and MyHeart [MYHEART] aim to provide solutions to improve the early detection of diseases and medical intervention.

Telemedical portals are being widely developed and deployed around the world, including the most economically strong countries like USA [USDD] or Australia [HEALTHSHARE], and those more challenging environments like Brazil [CYCLOPS] and India [WHC]. In Poland, telemedical portals are under development in Kraków and Warszawa. TeleDICOM developed at AGH - University of Science and Technology is a an environment for collaborative and interactive work on medical documents [CAŁA]. Warszawa based telewelfare.com is a portal offering an interactive service for diagnosis and rehabilitation of the senses responsible for communication [TELEWELFARE]. With the initiative described in this paper Poznań aims to contribute to this list of novel electronic solutions for support of the healthcare system.

BIBLIOGRAPHY

[PIONIER] Binczewski A., Mazurek C., Stroiński M., Węglarz J.: Academic networks for telemedicine – a "PIONIER" example. 7th European Congress on Telepathology, 8-11.07.2004, Poznań

[GSP1] BOGDAŃSKI M., KOSIEDOWSKI M., MAZUREK C., WOLNIEWICZ M., GRID SERVICE PROVIDER: How to improve flexibility of grid user interfaces. Lecture Notes in Computer Science 2657: Proceedings of the International Conference on Computing Science ICCS 2003, pp. 255-263, Berlin Heidelberg New York, 2003.

[GSP2] BOGDAŃSKI M., KOSIEDOWSKI M., MAZUREK C., STROIŃSKI M., Facilitating the Process of Enabling Applications within Grid Portals. Lecture Notes in Computer Science 3251: Grid and Cooperative Computing – GCC 2004, pp. 175-182, Berlin Heidelberg New York, 2004.

[GSP3] BOGDAŃSKI M., KOSIEDOWSKI M., MAZUREK C., RABIEGA M., WOLNIEWICZ M., Flexibility and user-friendliness of grid portals: the PROGRESS approach. To appear in Concurrency and Computation: Practice and Experience, John Wiley & Sons, Ltd.

[DMS] KOSIEDOWSKI M., MAŁECKI M., MAZUREK C., SPYCHAŁA P., WOLSKI M., Integration of the Biological Databases into Grid-Portal Environments. Proc. Workshop on Database Issues in Bioological Databases DBiBD, Edinburgh, 2005.

[NOT] ADAMSKI M., GRABOWSKI P., KUROWSKI K., LEWANDOWSKI B., LUDWICZAK B., NABRZYSKI J., OLEKSIAK A., PIONTEK T., PUKACKI J., STRUGALSKI R., GridLab Middleware Services for Managing Dynamic Computational and Collaborative Infrastructures (VOs). Proc. 13th Annual Mardi Gras Conference, pp. 35-40, Baton Rouge, 2005.

[GSI] BUTLER R., ENGERT D., FOSTER I., KESSELMAN C., TUECKE S., VOLMER J., WELCH V., Design and Deployment of a National-Scale Authentication Infrastructure. IEEE Computer, vol. 33, No. 12, pp. 60-66, 2000.

[DLIBRA] MAZUREK C., WERLA M., Distributed Services Architecture in dLibra Digital Library Framework. Proc. 8th International Workshop of the DELOS Network of Excellence on Digital Libraries on Future Digital Library Management Systems, Schloss Dagstuhl, 2005.

[ITVP] CZYRNEK M., KUŚMIEREK E., MAZUREK C., STROIŃSKI M., Large-Scale Multimedia Content Delivery over Optical Networks for Interactive TV Services. To appear in Future Generation Computer Systems, Elsevier Science.

[GSPHERE] NOVOTNY J., RUSSELL M., WEHRENS O., GridSphere: A Portal Framework For Building Collaborations. Concurrency and Computation: Practice and Experience. Vol. 16, No. 5, pp. 503-513, Chichester, 2004.

[CYCLOPS] Cyclops Project, RCTM: A Large-Scale Telemedicine Network for Public Health in Brazil, http://cyclops.telemedicina.ufsc.br/index.php?lang=en&page=telemedicine&subpage=rctm

[WHC] WebHealthCentre, http://papers.biohealthmatics.com/CaseStudies/Telemedicine/0000000110.aspx

[USDD] POROPATICH R., e-Health in the US Army – Future Trends and Transition to the Civilian Sector, Proc. Tromso Telemedicine Conference TTC2003, Tromso, 2003

[HEALTHSHARE] JOHNSTON B., Distributed E-Health on the Internet, Proc. Tromso Telemedicine Conference TTC2003, Tromso, 2003

[CAŁA] CAŁA J., CZEKIERDA Ł., TeleDICOM - environment for collaborative medical consultations. Proc. 1st International Conference on e-Health in Common Europe, Kraków, 2003.

[TELEWELFARE] Telewelfare portal. http://www.telewelfare.com

[MET] Michałowski, W., Słowiński, R., Wilk, Sz., Farion, K., Pike, J., Rubin, S., Design and Development of a Mobile System for Supporting Emergency Triage. Methods of Information in Medicine, Vol. 44, No. 1, pp. 14-24, 2005.