

VEMH - VIRTUAL EURO-MEDITERRANEAN HOSPITAL AND MEDICAL GRID

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Abstract: Due to the experience in the exploitation of previous European telemedicine projects an open Euro-Mediterranean consortium proposes the Virtual Euro-Mediterranean Hospital (VEMH) initiative. The provision of the same advanced technologies to the European and Mediterranean Countries should contribute to their better dialogue for integration. VEMH aims to facilitate the interconnection of various services through real integration which must take into account the social, human and cultural dimensions. VEMH will provide a platform consisting of a satellite and terrestrial link for the application of medical e-learning, real-time telemedicine and medical assistance. Due to the distributed character of the VEMH Grid technology becomes inevitable for successful deployment of the services. The methodologies for the VEMH are medical-needs-driven instead of technology-driven. They supply new management tools for virtual medical communities and allow management of clinical outcomes for implementation of evidence-based medicine. VEMH will provide access to the required quality of medical services depending on the individual needs of each of the partners.

Introduction

Telemedicine aims at equal access to medical expertise irrespective of the geographical location of the person in need. New developments in Information and Communication Technologies (ICT) have enabled the transmission of medical images in sufficiently high quality that allows for a reliable diagnosis to be determined by the expert at the receiving site [1-3]. At the same time, however, these innovative developments in ICT over the last decade bear the risk of creating and amplifying a digital divide in the world.

In recent years, different institutions have launched several Euro-Mediterranean telemedicine projects. All these projects have demonstrated how the digital divide is only a part of a more complex problem, the need for integration. Therefore, provision of the same advanced technologies to the European, to the Mediterranean and to the Adhering Countries should be the final goal for contributing to their better dialogue for integration.

During its implementation over the last two years, EMISPHER (Euro-Mediterranean Internet-Satellite

Platform for Health, medical Education and Research, EUMEDIS Pilot Project 110, see www.emispher.org/, co-funded by the EC under the EUMEDIS Programme, Strand 2, Sector 1; see www.eumedis.net/) has deployed and put in operation a dedicated internet-satellite platform consisting of currently 10 sites in 5 MEDA countries (Casablanca, Algiers, Tunis, Cairo and Istanbul) and 5 EU countries (Palermo, Athens, Nicosia, Clermont-Ferrand and Berlin) (see Fig. 1) [4]. The EMISPHER network hosts three key applications in the field of medical eLearning (EMISPHER Virtual Medical University with courses for under-graduates, graduates, young medical professionals, etc., in real-time and asynchronous modes), real-time Telemedicine (second opinion, demonstration and spread of new techniques, Telementoring, etc.) and eHealth (medical assistance for tourists and expatriates).



Figure 1: Centers of Excellence in the EMISPHER project interconnected by a satellite-based network for bridging the digital divide in the Euro-Mediterranean healthcare area.

Materials and Methods

Due to the experience in the exploitation of previous European telemedicine projects and, in particular to activities carried out in the framework of the EUMEDIS programme, an open Euro-Mediterranean consortium would like to propose the Virtual Euro-Mediterranean

Hospital (VEMH) initiative.

VEMH aims to facilitate and accelerate the interconnection and interoperability of the various services being developed (by different organisations at different sites) through real integration. This integration must take into account the social, human and cultural dimensions and strive towards common approaches but open and respectful of cultural differences: multi-lateral cooperation instead of aid.

VEMH is not only to justify and demonstrate telemedical demands in the Mediterranean area but also to integrate the medical expertise in this region and to assist the transfer of “know how” from the north to the south and from the west to the east.

VEMH is dedicated to bridging a digital divide by establishing high quality equal access to real-time and on-line services for healthcare for all of the countries of the Euro-Mediterranean area.

Tele-consultation between experts and referring doctors contributes to improved patient care through recommendations for new treatment and timely access to specialist knowledge.

VEMH will provide a heterogeneous integrated platform consisting of a satellite link, such as in the EMISPHER project, and a terrestrial link, like in the EUMEDCONNECT project, for the application of various medical services, such as medical eLearning, real-time Telemedicine and medical assistance. Evidence-Based Medicine will be more and more integrated in these three main dedicated medical services.

VEMH would also like to benefit from the results and experience of different cooperation projects such as EMISPHER - www.emisphere.org/, BURNET - www.burnet.org/, PARADIGMA - www.paradigmamed.org, EMPHIS - www.emphis.org/, EUMEDGEN - www.eurogene.org, ODISEAME - www.odiseame.org, EUMEDCONNECT - www.eumedconnect.net/ and GALENOS - www.rtk-berlin.de/op2000/Deutsch/projekte/galenos.html.

To approach the identified telemedicine services the following requirements need to be considered:

- traffic-intensive applications such as teleconsultation, telediagnosis, and teletraining require real-time interactivity of the audio and video stream;
- high quality of images and video transmission: min. 386 kbps up to 1 Mbps;
- guaranteed bandwidth: transmission of medical data does not allow for transfer delay and quality loss;
- guaranteed confidentiality of patient data.

Therefore, considering also the non-fully operating terrestrial infrastructures of the relevant sites and the bandwidth requirements, satellites are the most fitting infrastructure for the envisaged set of VEMH services.

The proposed services will be mainly based on UDP (User Datagram Protocol) a connectionless protocol

that, like TCP, runs on top of IP networks. In satellite networks with a transfer delay of approx. 600 ms only the UDP protocol allows for an optimized transmission.

The VEMH system adopts the meshed network topology. The meshed network uses VSAT terminals for communication directly through the satellite. Since a single hop link is involved, therefore ensuring low delay times, this kind of network is widely used for voice and video-conferencing applications. These networks can be configured on demand-assigned basis. Over this meshed topology it will be possible to implement:

- point to point connections (for tele-consultations)
- point to multipoint (for tele-training)

WinVicos (Wavelet-based interactive Video communication system) is a high-end interactive video communication system with real-time video, still image and audio transmission. The system has been optimized with regard to interactive telemedical applications (teleconsultation, second opinion, telementoring, teleteaching, etc.). For video compression WinVicos uses a hybrid, speed-optimized wavelet-codec (PACC, Deutsche Telekom patent DE 197 34 542 A1).

WoTeSa (Workstation for Telemedical applications via Satellite) is the hardware on which WinVicos is operated. The hardware requirements are met by an IBM-compatible PC with Pentium IV processors (>3 GHz), 512 MB RAM, two Osprey video capture cards and two cameras as live video source and document camera. The S-Video and Composite-Video inputs of the Osprey cards can directly be connected with the various medical equipments. Details of WoTeSa/WinVicos have been described in [5-6].

Results

VEMH services and activities are related to the areas Mediterranean Medical University, real-time



Figure 2: Interactive tele-education session between IsMeTT (Palermo) and UCY (Cyprus) in the EMISPHER project

Telemedicine, Medical Assistance and Fellowship Programmes.

eLearning: In the project the Mediterranean Medical University (MeMU) will be developed. The leading medical centres integrated in the network provide pedagogical material and modules for synchronous and asynchronous eLearning in their medical specialities: endoscopic surgery, gynaecology-obstetrics, reproductive medicine, infectious diseases, interventional radiology, liver and multi-organ transplantation, tumour diagnosis and therapy, etc.. The central gateway to MeMU is the integrated satellite- and terrestrial-based platform and will provide the users with access to various contents in the network and support the participation in real-time e-learning events (see Fig. 2-3). The exchange between the partners of various countries and availability of standardised educational modules allows for improved qualification of undergraduate and graduate students, hospital staff, general practitioners, healthcare officers and other professionals in the medical field.



Figure 3: eLearning session with transmission of live ultrasound videos from Charité (Berlin) to Ain Shams University (Cairo), Agence Nationale de Documentation de la Sante (Algiers), Faculte de Medicine et de Pharmacie (Casablanca) and University of Cyprus (Nicosia)

Real-time Telemedicine: VEMH will offer applications in second opinion, tele-teaching & tele-training (demonstration and spread of new techniques), tele-mentoring (enhancement of staff qualification), undergraduate teaching courses, optimisation of the learning curve. The leading medical centres in the project provide expertise in open and minimally-invasive surgery, multi-organ transplantation, endoscopy, pathology, radiology, interventional imaging, infectious diseases, oncology, gynaecology and obstetrics, reproductive medicine and emergency and disaster medicine.

These real-time interactive telemedical applications contribute to improved quality of patient care and to



Figure 4: Interactive multipoint tele-consultation during laparoscopy (Charité (Berlin), Ain Shams University (Cairo), University of Cyprus (Nicosia)) in the EMISPHER project

accelerated qualification of medical doctors in their respective speciality (see Fig. 4-5). Thus, this international network of distributed but integrated competence contributes directly and indirectly to improved healthcare.

Medical assistance: As tourism constitutes a substantial economical factor in the Mediterranean region and because of the increasing mobility of the population, continuity of care through improved medical assistance is of major importance for improved healthcare in the Euro-Mediterranean region. The introduction of standardised procedures, integration of the platform with the various local and national communication systems, and training of the medical staff involved in medical assistance allow for shared management of files related to medical assistance (medical images, diagnosis, workflow, financial management, etc.) and thus for improved care for travellers and expatriates in the Euro-Mediterranean region.

The next service in VEMH will be the Evidence-Based Medicine (EBM). EBM cannot substitute the agreement on concrete and individual therapeutic procedures to be followed; however, even for the individual patient EBM provides a more solid base for individual decisions. EBM contributes to better disease management. Health care policy makers can also expect great potential from EBM.

Fellowship programme: VEMH will offer individual grants to 20 young medical doctors coming from the Mediterranean and from accession countries. Each fellow will be trained, for a minimum period of 18 months, in one of field of the MeMU through the tele-teaching and tele-training VEMH services. This training programme will include an internship period in some of the clinical and scientific institutions of the VEMH consortium. The VEMH faculty will constantly monitor the progresses of the fellows and will evaluate them at the end of the training period.



Figure 5: Second Opinion during a telepathological consultation between Charité (Berlin) and Faculte de Medicine et de Pharmacie (Casablanca)

The scope of the fellowship programme is to allow young medical doctors to develop and gain experience in a multicultural and multidisciplinary environment. This will facilitate the creation of a new generation of physicians that are able to understand and work with different needs and cultures. The fellowship programme is a major component for the real integration among all the countries.

Due to the distributed character of the VEMH, data, computing resources as well as the need for these are distributed over many sites in the Virtual Hospital. Therefore Grid becomes inevitable for successful deployment of services like acquisition and processing of medical images, data storage, archiving and retrieval, data mining (especially for evidence-based medicine) [7]. To achieve this conventional Grid technology has to be expanded to cover not only local computing resources but to a dimension of organisation spanning integrated networks.

Giving access to distributed services in a wide network of connected institutions the system shall integrate domain knowledge, powerful computing resources for analytical tasks and means of communication with partners and consultants in a trusted and secure user tailored support system.

Here we introduce our view of an agent-based Metagrid Service Engine (MGSE), which implements an additional software layer between proprietary Grid engines and the applications and therefore integrates the different approaches (see Fig. 6). It will make a global Grid across OEM-boundaries become reality.

The Metagrid Services should address the main issues of today's Grid Computing software. Low level Grids like the SUN Grid Engine provide scalable high performance Grids but have several requirements and shortages that need to be taken care of. First they need homogeneous Grid nodes because scheduled tasks contain only scripts designed to call the programs needed for the tasks.

Furthermore the low level design does not handle AAA aspects too well. When applying the ideas of inter-organizational Grids this becomes a very important issue, as perceived by the Global Alliance. Focusing heavily in this partial area, the Open Grid Service Architecture (OGSA) uses Web Services and sophisticated Authentication and Authorization techniques. Web Services allow a platform independent approach, combined with the included security mechanisms this becomes an important basis for the Global Grid vision [8].

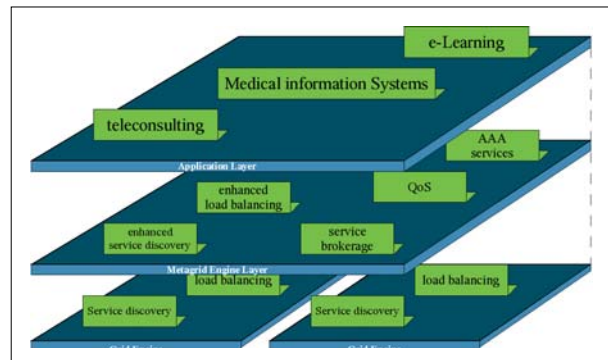


Figure 6: Agent-based Metagrid Service Engine (MGSE)

Discussion

The methodologies for the VEMH are medical-needs-driven instead of technology-driven. They provide new management tools for virtual medical communities and allow management of clinical outcomes for improved implementation of evidence-based medicine. By the integration of different telemedical solutions in one platform many different medical services shall be supported.

Security of data will be assured by the fact that the communication system adopts a coding algorithm owned by members of the Consortium. The transmitted data can only be decoded by this software. As one of the members of the Consortium owns the software licences, this provides an initial level of data security through the license distribution and management. During the course of the project an additional 128 kbit security key will be implemented to differentiate between different (parts of the) networks, as required.

Privacy will be assured during the validation project simply by the fact that anonymous examinations will be done, and the patient will be identified only with an ID code. However when the service is deployed, the guarantees of privacy will be given by the data security system. This system will ensure that a comprehensive set of controls comprising best practices in information security are used by the service.

The justification of the various VEMH services and applications will be assessed by using a comprehensive evaluation methodology. This will in particular examine various outcomes including clinical, organisational, and

economic as well as other relevant outcomes. The criteria under which such services can be evaluated are based upon the work of Bashshur [9]. The rationale for using this type of methodology is to ensure that the services or applications are capable of having an immediate and positive impact upon patient care in the VEMH region.

VEMH Topics:

- system integration by each of the partners
- verification of the real needs for each partner individually
- verification of the young specialists by each of the partners and training depending on the real needs; management of fellowships: realization of distributed distance training using the VEMH network
- tele-mentoring for Evidence Based Medicine
- analysis of different cost models and recruitment of additional sponsors
- evaluation and assessment of services and applications

VEMH Outcomes:

- guidelines for different diseases in the different medical fields, e.g. dermatology, endoscopy, radiology, pathology, etc. presented in standardised way,
- education on these new standards for all users and future users,
- new eLearning interactive tools,
- quality control / score of quality.

VEMH Benefits:

- increased effectiveness
- accelerated decision making
- improved quality of decisions via real-time global exchange between experts reducing the travel
- integration of the human resources in this region

The main topic in VEMH will be the work and education of young specialists. The developed platform by the key partners integrated in the project will be open as service platform to everybody. The effectiveness will be measured not on the base of technological aspects but on the visibility and the success of the medical eLearning, tele-teaching, tele-training, tele-mentoring, tele-consultation, etc.

Conclusions

VEMH will foster cross-Mediterranean cooperation between the leading medical centres of the participating countries by establishing a permanent medical and

scientific link. Through the deployment and operation of an integrated satellite and terrestrial interactive communication platform, VEMH will provide for medical professionals in the whole Euro-Mediterranean area access to the required quality of medical service depending on the individual needs of each of the partners. For the successful deployment of the various medical services in the VEMH the development and implementation of Health Grid technology appears crucial. The applications in the area of eLearning, Real-Time Telemedicine and improved Medical Assistance contribute to an improved health care in the Euro-Mediterranean area and build the basis for the introduction of evidence-based medicine.

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