HealthManagement
Promoting Management and Leadership

Volume 1 / Issue 1 Spring 2006 - Features

Designing a High-Performance Telemedicine System

Authors

A.V. Bogdanov

Organisation: Institute for High

Performance Computing and Information Systems, Russia

Email: bogdanov@csa.ru

Website: www.csa.ru

A.B. Degtyarev

Organisation: Institute for High

Performance Computing and Information Systems, Russia

Email: deg@csa.ru

Website: www.csa.ru

Yu.I. Nechaev

Organisation: Institute for High Performance Computing and

Information Systems, Russia

Email: int@csa.ru

Website: www.csa.ru

A.V. Valdenberg

Organistion: Leningrad Region

Clinical Hospital, Russia

Email: walden@mail.ru

Website: www.oblmed.spb.ru

For a copy of references contained in this article, please contact k.ruocco.me@eahitm.org.

In the first of this three part series, the steps taken for designing a telemedicine system based on high-performance computer technology for the Institute of High Performance Computing and Information Systems in St. Petersburg, Russia is explained. In this general approach, the creation of this telemedicine system and the applications of new technologies for cardiologic aid tasks focuses on users with various cardiologic medical qualifications. However, the basis of the developed approach could be used for information processing in other medical fields.

In the second part , the concept proposal for a telemedicine Internet portal will be identified, the role of a territorial telemedicine centre in relation to the distributed organisation will be discussed, and the functional prototype for a distributed telemedicine cardiologic system will be explained. In the final instalment, complex telemedicine architectures will be explored, along with how to integrate knowledge management and processing into the system; foundations of information processing and complicated situational modelling will be explained, with the series concluding by mapping a probabilistic model in a cluster architecture to achieve high-performance computing.

Telemedicine Development is the Basis for Enhancing Modern Medicine , the main purpose of which is to provide medical services to remote patients located far from medical centres and who have limited access to medical services. The basis for telemedicine development is therefore the creation of a system capable of providing effective information transfer between users and providers of medical services, as well as other various levels of service providers. As the aim of a telemedicine system is to provide global, united and permanent access to medical care in real time through the use of modern communication and information technologies, a solid technical base for the transfer and reproduction of data makes it possible to launch videoconferences and transfer high-quality digital images at a distance, allowing for more efficient reanimation aid, faster transportation of the patient and quicker medical decisions1,2,5.

The Necessity of Telemedicine Development is dictated by various issues. The main circumstances are created by situations in which time and distance are critical factors. With a reference to cardiology, the basic spheres of telemedicine systems application can include the following:

+ emergency clinicoelectrocardiographic consultations, for instance, situational circumstances requiring electrocardiogram registration and tactical decision-making in the absence of the specialist (i.e., personal time off, in small medicalpreventive offices where the expert is not in staff, etc. – when therapeutists, emergency doctors, and general practitioners need to ask for help);

+ complex clinical situations demanding the help of regional specialists (any time cardiologists, heads of cardiology and therapeutic departments ask for help), and

+ planned clinicoelectrocardiographic consultations.

There are Many Challenges to Telemedicine in the Consultation Process , which is carried out in the following way: first, an electrocardiogram of the patient is registered and transferred through telemetric systems; the clinical consultation of the cardiologist then takes place. For many years this scenario has shown its effectiveness - as long as it allows for fully informing the doctor, especially in an emergency situation, about modern methods of diagnostics and specific treatments, to help to avoid diagnostic mistakes. At the same time, with regards to the features of rural public health services, the system of consultations is improved. In this case, one can use essentially more intensive and productive consultations.

These activities are important not only for cardiology, as they have, in a certain sense, a universal character. It is therefore possible to emphasise the following basic problems of telemedicine that demand a solution and realisation:

+ information acquisition on the status patients in remote mode;

+ heterogeneous medical information transfer;

+ assimilation and pre-processing of incoming medical data;

+ timely and, whenever possible, qualified reaction in automatic mode on complicated personal health cases;

+ maintenance of timely and highly skilled consultations and statements of medical diagnosis;

+ detailed information-analytical doctor support for correct diagnostic and choice of effective patient treatment;

+ conducting virtual consultations and doctor teleconferences, and

+ multithread processing of medical information arriving from multiple remote sources.

The Main Goals and Functions of a Telemedicine System

include a variety of methods, procedures and technical criteria. The first of these is the automation of performing partial or full medical examinations, utilising the opportunities of computer technologies for primary consultations with medical advisers who are not always on duty in the consulting office, including doctors of adjacent specialities, etc. This allows for the opportunity to expand essential consultations, in particular: to organise dispensary and preventive examinations, to supply social services using necessary data, to provide consultations for remote patients who are unable to travel to polyclinic institutions, pre-shift examinations in locomotive depots, etc. Next is the application of methods based on electro-cardiography, but intended for more detailed diagnostics of Blood Circulation System (BCS) illnesses, for example, the analysis of cardiac rate variability, the research of heart rate potentials, and conducting tests of physical activity, etc.

The third objective is remote consultation utilising diagnostic methods based on other principles of information retrieval. For instance: the remote registration of heart noise (phone-cardiography), in combination with electrocardiograms and clinical data, can assist modern diagnostics of heart diseases, especially in a children's practice. Currently, the number of revealed heart diseases among children is much less than expected (two cases in 1,000 newborns) due to insufficient auscultation skill among children’s doctors in maternity hospitals. Doctors, especially in small clinic prophylactic organisations (CPO), cannot in all cases and in proper time diagnose infectious endocarditis, the defeat of heart valves under myocardial ischemia, etc. Wide application of echocardiography methods, in this case helps, but does not solve, the problem because of the impossibility of meticulous examination and the necessity of high qualifications of a doctor- and from the other side due to the impossibility of emergency treatment or treatment outside the CPO, and the remote transfer and archiving of ultrasonic probes (US), in particular, echocardiographies. It represents especial interest in view of the fact, that CPO in regions are equipped by the same devices of ultrasonic scanning having the option of telemetric data transmission.

Another objective is the successful remote testing and reprogramming of implanted artificial rhythm drivers (electro-cardiostimulators or pacemakers). According to information from the Leningrad Regional Cardiologic Dispensary (LRCD), acting as the Regional Centre of Surgical and Intervention Arhythmology in Russia, there are about 1,300 patients with implanted pacemakers in the Leningrad region alone. There are approximately 150-160 pacemakers implanted annually (without taking into account the replacements), i.e. the intensity of implantation is about 100 in one million of the population per year. Thus, the number of patients continuously increases. The majority of patients with heart blockage, at which pacemakersare implanted, are elderly. The transport availability of cardiologic clinics for these categories of patients is rather low.

Existing techniques of patient monitoring provide for the testing of pacemakers once in half a year. Therefore, approximately 2,600 persons per year would need to visit centres testing such devices. However, the actual number of visitors to specialists in the testing and programming of pacemakers seldom exceeds 100 in a month, and the number in a year is about 1,000 (holidays considered). These figures demonstrate that more than half of patients do not regularly check the functioning of their pacemakers! In many respects, this is connected with the fact that patients often cannot travel to St. Petersburg for these procedures.

Work practice shows that nine out of ten people do not require any changes in their pacemaker parameters after testing. In these cases follow-up visits are carried out not under medical indications, but through a clinic survey, thus, the consulting polyclinic of the LRCD carries out only clinical supervision.

As a result, the cardiologic cabinet of the local polyclinic that should carry out supervision is actually removed from the process. The organisation of remote testing will bring this type of medical aid to patients in remote territories. In doing so, it will allow for performing these test procedures on patients who did not visit experts in the LRCD for many years, as well as improving the quality of prophylactic medical examinations on patients with pacemakers.

Finally, the fifth objective is the development of a medical server with a distributed database that contains data not only about consulted patients, but also that actively reveals the early stages of BCS illnesses, for example arterial hypertensia, with the possibility of the automatic measurement of blood pressure, growth and weight, tracking in dynamics, etc. This makes it possible to decrease the death rate from a sudden heart attack and insult due to performing preventive actions.

Published on : Mon, 3 Apr 2006