Volume 1 / Issue 2 Summer 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 part of this series, (published in Issue 1 of Healthcare IT Management this Spring) the steps taken towards designing a telemedicine system based on high-performance computer technologies for the Institute of High Performance Computing and Information Systems in St. Petersburg, Russia were explained. In this article, the concept proposal for a telemedicine Internet portal, the roles of a territorial telemedicine centre in relation to the distributed organisation and the functional prototype for a distributed telemedicine cardiologic system are addressed.

Developing a Telemedicine Internet Portal

One of the major tools used towards achieving the system design of a high-performance telemedicine system, as described in Issue 1, is a telemedicine Internet portal. The portal represents a specialised program with a complex framework of Internet technologies. Its basic purpose is to associate medical information network resources in a uniformsystem in order to achieve the following:

+ The remote consultation of specialists,

+ A reference information service,

+ A medical statistical service, and

+ the remote training of medical personnel.

Concerning the remote consultation of specialists, the portal contains an extensive database with information about leading medical institutions that support remote consultations and provides access to it for doctors and patients. All user requests are classified based on categories of consultations and automatically directed to the corresponding specialist. The diagnosis of the specialist, with the preservation of all necessary conditions of confidentiality, is similarly achieved. The use of a remote advisory service improves the quality of diagnostics for diseases and in choosing the correct course of treatment. Therefore, statistics of disease outcomes (e.g. lowering of the death rate, physical inability and a reduction of disability time) are optimised.

The reference information service of the portal includes a database of medical resources available in a region: basic hospitals (with profiles), polyclinic complexes, stomatological and diagnostic centres, pharmacies, etc. It defines the role of specialised medical service reception and simplifies the admission procedure. In addition, the portal can contain updated references to the Internet resources concerning supported types of diseases.

The medical statistical service is based on regular information acquisition reflecting clinical, organisational and epidemiological characteristics of diseases, organisation of medical aid, and results of remote consultations. A special interest represents an opportunity for the efficient updating of various specialised databases (registers) online by inputting records from distant clinic prophylactic organisations (CPOs), ensuring an efficient and up-todate database.

Analysis of data and their comparison with the characteristics of ecological conditions in a region permits the permanent monitoring of citizens' health states, receiving information profiling the details of medical institutions, revealing "doubtful" cases of treatment for which interdepartmental examination are required, and also determining statistical standards of treatment duration and costs across various groups of diseases. It also provides an opportunity to plan illness payments with more flexibility, efficiency, and with due consideration towards the specifics of the given region. This function of the portal is therefore only accessible to regional or departmental administrators and specialists.

Remote improvement of the professional skills of medical personnel is the most accessible method carried out with daily practice. The portal provides an opportunity to access leading libraries and periodicals in the field of public health services and remote training, along with popular scientific and reference information in the medical field.

It should be noted that remote consultations conducted with the use of standard Internet portal tools sometimes have a low validity. Increases in this are necessary in order to: maintain interaction between patients and physicians; develop "virtual consultations"; receive texts, video images and results of laboratory diagnostics (including modern medical technique); and develop specialised telemedicine centres and networks of telemedicine points in remotely CPOs. The centre is an integral part of a telemedicine system for consultations and improving professional skills. It has complex hardware and software, including equipment for teleconferences and projective video systems. The structure of the centre also includes a virtual reality system that improves the quality of distance learning and professional skills of medical staff.

Development of the High-Performance Telemedicine System

In accordance with this proposed concept, the development of a high-performance telemedicine system is now in progress. This system is based on developed prototypes of cardiologic real-time telemedicine systems. Developing telemedicine centres territorially represents the distributed organisation that consists of:

+ mobile cells of the telemedicine network of remote patients;

+ distant CPOs and regional medical institutions – hospitals, big polyclinics and medical institutions in large rural settlements will be considered as CPOs, being the centres of medical statistical information gathering. Small rural medical aid stations are also based on these CPOs;

+ central servers for conducting telemedicine information gathering and processing from mobile cells of telemedicine networks and distant CPOs; and

+ equipment parts contained in general-purpose regional super computer centres. Unique computational and visualisation resources, archives and storage capacity of large volumes of information will be used.

This functional prototype (telemedicine cardiologic system) represents a three-level distributed system including:

+ Remote Automated Workplaces (RAEW) of doctor / medical assistants for the gathering, reception and transferring of medical information (both the measurement of data and results of medical examinations);

+a central kernel of telemedicine systems for the gathering, processing and assimilation of information; and

+RAEWs of medical experts.

RAEWs are being built on the basis of mobile personal computers, or handheld computers, together with specialised portable medical equipment such as cardiographs and measuring instruments for blood pressure, pulse, etc. Remote implanted equipment such as cardiac pacemakers and other similar devices are also considered. RAEWs are consequently supported by doctors, in remote mode, from telemedicine centres. The following demands are therefore made on this equipment and software:

+equipment and software must be simple to use by medical personnel of average qualification;

+ it should be multipurpose in its function;

+it must have high reliability: to restore itself automatically in case of failures, to possess noise immunity, to maintain work in an aggressive environment (moisture, impacts, vibration, etc.); and

+it has to be inexpensive and easy to duplicate.

Except for doctors' mobile RAEWs at the first level of the system, the network of fixed specialised telemedicine aid stations in distant CPOs is considered. These serve as the intermediate centres of information accumulation, for the formation of necessary medical and statistical data. They are also intended to be used for performing consultations and improving the professional skills of CPO medical personnel.

The proposal for the central kernel of the telemedicine system is based on two types of computer centres: 1) specialised hardware- software medical systems intended for direct work with RAEWs of doctors and medical assistants, and 2) general purpose equipment in a powerful supercomputer centre.

As the first specialised medical part cluster of high availability intended for operative information processing, medical equipment control, mathematical modelling, real time expert system operation, recommendations and processing of online doctors' requests from RAEW is considered. In addition, the distributed hardware-software system is intended to support the telecommunications components of the project, the organisation of virtual consultations and also the operation and processing of requests to specialised databases and archives stored on general purpose equipment located in regional supercomputer centres.

Functionality of Computers and Data Storage

Computers and data storage devices in the supercomputer centres are functionally intended for:

1 medical archive creation and the long-termstorage of information that is not already accessible;

2 the development and maintenance of heterogeneous medical information systems;

3 the supply of telemedicine portals by Internet services;

4 gathering, assimilation and storage of medical and statistical information; and

5 situational modelling in the field of public health services, the use of virtual reality systems, and conducting teleconferences, etc.

An archive system permits working with any type of document, making it possible to store previously viewed medical information (cardiograms, case history data, X-ray and other images). The file, placed in an archive, is registered and supplied with an electronic digital signature and cryptographic protection. It is then linked to other information that will allowfor increased effective information inquiry, extraction and utilisation.

Such an approach makes it possible to provide a high level of information protection in order to prevent the overload of specialised medical servers. In this case, the archive system only conducts operational work and provides medical personnel with reliable access to archived contemporary records by means of standard network interfaces. It is on the basis of the central kernel that the development of teleconference systems are arranged, allowing for the effective retraining of medical staff and the improvement of their qualifications with the use of unique computer equipment and virtual reality systems. RAEWs of medical experts are therefore intended for remote postponed consultations in instances of especially important and serious cases for the specification of diagnosis and use of unique experience of concrete medical specialists.

Published on : Sun, 16 Jul 2006