

MEDICAL APPLICATIONS AND HIGH SPEED NETWORKING

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Abstract: Medicine is a source of interesting applications that require high-quality infrastructure and a high throughput capacity. The CESNET association has been interested in this area for some time. In the second half of the 1990s, many medical videoconferences were held, and the infrastructure of the CESNET association was used for the transmission of medical image data. As interest in medical projects has been growing, a new independent activity, Medical Applications, was started in the second half of the year 2004. The intention of this new activity is to search for and develop other projects in the field of medicine.

Introduction

CESNET, association of legal entities, was held in 1996 by all universities of the Czech Republic and the Czech Academy of Sciences.

Its main goals are:

operation and development of the Czech NREN (National Research and Education Network),

research and development of advanced network technologies and applications,

broadening of the public knowledge about the advanced networking topics.

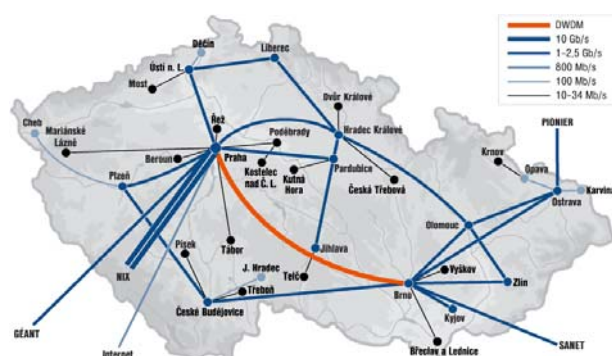


Figure 1: The infrastructure of CESNET2 network (topology valid since June 2005)

The CESNET2 network has following independent international connections:

- 2.5 Gbps to GÉANT, used for academic traffic,
- 800 Mbps to Telia, used for commodity traffic,
- 10 Gbps to NetherLight for experimental traffic,

1 Gbps to SANET, academic network of Slovakia,
1 Gbps to PIONIER, Polish optical academic network.

Medicine is a source of interesting applications that require high-quality infrastructure and a high throughput capacity. The CESNET association has been interested in this area for some time. In the second half of the 1990s, many medical videoconferences were held, and the infrastructure of the CESNET association was used for the transmission of medical image data. As interest in medical projects has been growing, a new independent activity, Medical Applications, was started in the second half of the year 2004.

Many activities (such as Virtual Environment for Cooperation, MetaCenter, and Distance Learning) were related to medical applications and were undertaken using their general techniques and procedures. Our approach is to search for new projects and enlarge current programs with specific features that are required after processing medical data, rather than to repeat these general procedures.

The following projects were implemented in the second half of 2004:

Standard environment of medical applications

Formalization and transmission of data on oncology patients

Videoconference for remote consultations in genetics – telegenetics

Development of the MeDiMed project

Searching for new telemedical applications

The staff of the 2nd Medical Faculty of Charles University in Prague and Masaryk University in Brno were directly involved in the said activity. In addition, staff from EUROMise (a joint facility of the Academy of Sciences of the Czech Republic and Charles University of Prague), Constitutional Court in Brno, Thomayer Faculty Hospital, Central Military Hospital, Masaryk Memorial Cancer Institute, the 1st Medical Faculty of Charles University and the firm IMA s.r.o. took part in working groups in the implementation of individual projects and the preparation of joint grants applications for the next grant period.

Standard environment of medical applications

Standardization and transparency of the legal environment which defines the communication between healthcare entities are among the key problems in communication between medical facilities. In addition,

the harmonization of our legal environment with EU legislation is crucial in order to avoid working on something that already exists in Europe. Making these issues transparent is essential for the acquisition of new partners among healthcare facilities, because some managers of these institutions are afraid to transmit data outside the hospital area.

Concerning the area of harmonization of the legislative environment and standards, we have established successful cooperation with the staff of EUROMise and with a lawyer from the Constitutional Court, who is involved in the analysis of information about legal aspects of maintaining medical records and telemedicine in EU countries.

A general introduction has been prepared which discusses the concept of the existence and mutual interactions of legal systems, the national law of the EU member country vs. EU law vs. international law. This general section is important for understanding the principles that serve as a basis for specific legal regulations.

Concentration on more specific problems will follow. In the first place, Czech legal regulations for the maintenance of medical records will be studied. This will involve analysis of the possibilities for the maintenance of medical records in electronic form, including the issues of Act No. 20/1966 Coll. on Public Healthcare (especially Section 67a et seq.), the Electronic Signature Act (227/2000 Coll.) and the Personal Data Protection Act (101/2000 Coll.). The work will also deal with penalties that might be considered in the event of a breach of the duties set forth in respect thereof in the legislation (administrative infractions or, as the case may be, criminal acts).

The next step will deal with the European legal regulation, including directives, or other legislation of the EU governing the said issues. At the European level, this will include the possibility of transmitting personal data (or information from medical records) between member countries.

We anticipate that the first complete publication of these materials in the form of a study or article in a scientific journal will be ready at the end of the year 2005.

Formalization and transfer of data on oncology patients

The formalization of oncology patient data is a brand-new activity. A method has been completed and tested for exporting current and archived data from whole-body gammagraphy of thyroid gland carcinomas. In addition, procedures have been prepared for the transformation of images into the standard graphic format. The objective is the further processing of the individual images and their sequences, the quantitative evaluation of thyroid gland activity and searching for potential secondary carcinoma foci.

XML presentations of data from the history records of the unique database of thyroid gland carcinoma have

been created. XML presentations were used to create database structures for SQL database and web forms for effective data input.

This method is used to process two basic data sentences of the carcinoma database: input data of individual cases (a card to be completed during the first meeting with the patient) and longitudinal data to be completed during each checkup.

The establishment of this database is required for involvement in future national and international cooperation. One example is the involvement planned in the project of the informational society program titled "Intelligent support for decision-making during diagnostics and therapy in nuclear medicine using Bayes processing of uncertain data and probability mixtures", which is being undertaken by the Institute of Information Theory and Automation of the Academy of Sciences of the Czech Republic.

In addition, a proposal has been submitted for a project for the 6th Frame Program in the area of Life Sciences, with participation in the Network of Excellence for research in cystic fibrosis.

In terms of the further processing of data, it is important to establish contacts with the authors of the MEDAL (Medical Algorithms Project) system, which are algorithms of freely distributable-type programs for medical data processing.

We do not expect to produce publications in this area until the second half of the year, given the short term of implementation.

Videoconference for remote consultations in genetics – telegenetics

We are continuing work on the successful project of videoconferences for remote consultations in medicine focused on genetics, also known as telegenetics. A proposal has been made and testing has been prepared for specialized functions of a communication mirror that is suitable for teleconference modes and round-table-type presentations. In addition, the required functions of the client programs have been specified.

In cooperation with EGF, a storage space for digitalized video recordings of lectures held in the European School of Genetic Medicine, including accompanying documentation, has been created and made accessible. Statistics and a model example for content-driven pre- and postgraduate medical education are also available.

For the purpose of international connectivity is used high-speed infrastructure of academic network project, e.g. GÉANT.



Figure 2: Topology of European high-speed network GEANT

Together with the University of Bologna, a pilot project for the EU program “Leonardo” (support of professional education) has been prepared. A project is now available for interconnection of communities of geneticists and hematologists studying thalassemia (genetic hematopoietic disorder) for the 6th Frame program. The University of Bologna is a partner for education, while CESNET is a partner for infrastructure.

Development of the MEDIMED project

The enlargement of the MEDIMED project into the Prague locality has been successfully implemented by connecting Thomayer Teaching Hospital (FTN) in Prague during July 2004. Based on the experiences of real-time operation, FTN invested approximately CZK 30 million to equip the PACS center and is now interested in establishing the PACS center for the Prague locality. The connection of the General Teaching Hospital (VFN) and Bulovka Teaching Hospital is under negotiation.

Anonymization software for PACS has been created in cooperation with the CESNET association, MU Brno, Masaryk Memorial Cancer Institute and the firm TATRAMED s.r.o. The system is designed for students of medical sciences and for new hospital radiologists.

Currently, the functionality of the anonymization module, a general version of the description editor, and

a module for the administration of case studies are being tested in real operation.

After being filled with data, the database of anonymous image studies intended for teaching will be made accessible to students of the Medical Faculty of the MU in the classroom of the Biostatistics and Analysis Center of the Medical Faculty and Faculty of Natural Sciences of the MU in Brno. This Center is equipped with 30 high-power PCs and high-quality LCD monitors and TomoScan licenses.

The system may be operated at selected sites of cooperating teaching hospitals, subject to an agreement.

The results of these partial activities were presented at the prestigious IASTED conference in the USA in November 2004 and during eHealth 2005 conference and exhibition at Tromso, Norway. The MeDiMed project was mentioned during introduction to the Ministerial Round Table as a success case study [8].

Developing technical resources of the system

The training system is being developed in cooperation with the firm TATRAMED s.r.o. This system involves the modification of the current commercial concept, which has been extended to include special components for teaching purposes. The system is designed to meet all the compatibility requirements needed for systems working in real operation.

The key components of the implementation are in particular:

- anonymization module (all information enabling the patient’s identification is removed from an image study);

- editor enabling the addition of an image description in the DICOM Structured Report format

- support of work using key words (for easy retrieval, and so on);

- an extension for the creation of teaching programs (specialized editor enabling the creation of problem-oriented, specialized case studies with references to image information).

Workstations connected to the teaching system, which enable the anonymization and sending of image studies to the PACS database, have been installed in Masaryk Memorial Cancer Institute, the Clinic of Pediatric Oncology of the Teaching Hospital of Brno, St. Anna Teaching Hospital of Brno, and the Center for Cardiovascular and Transplantation Surgery in Brno.

Inclusion of the image study into the teaching system

Each image study included in the teaching system can be provided with a structured signature (in the format according to the international DICOM standard) and with the set of attributes (key words).

The structured signature can be logically divided into several parts, according to the character of the project, as follows:

- Description of the image study

Description of the diagnostic procedure used

Basic (technical) attributes of the image study are automatically saved upon inclusion of the image study into the teaching system. The values of these attributes are based on the original image study obtained during the routine operation.

Modality (CT, US, PET/MR, PET/CT ...);

Name of the healthcare facility where the examination was performed;

Date of examination;

Patient's year of birth (the actual date of birth should be transformed, for example, into 1/1/1964);

All technical parameters of the examination (distance between sections, number of images, number of series ... and so on).

Case study

A case study shall mean a document comprising independent text pages with the possibility of references to image studies (such as DAPET). The teaching system will contain tools (specialized, purpose-adjusted editors) enabling radiologists to create their own case studies.

Further development

Coordination for the definition of new key words

Training users;

Thomayer Teaching Hospital is taking part in the preparation of draft contents and development;

Many district hospitals, teaching hospitals and specialized healthcare facilities throughout the Czech Republic are interested in joining the system;

Currently particular attention is paid to the fields of oncology, pneumology and cardiology

Solving security issues (access authentication, hierarchy of certification authority)

The system is designed so that its usability is open to foreign cooperation

Searching for new telemedical applications

As part of activities for the second half of the year 2004, two new grants of the Informational Society program, which were announced by the Academy of Sciences of the Czech Republic for a period of up to 5 years starting from 2004, were successfully prepared and defended. The first project is MediGRID, with the 2nd Medical Faculty of the Charles University being the main researcher, and Masaryk Hospital in Ústí nad Labem and the CESNET association being fellow researchers. The second project is "Effective processing of medical image information" with the CESNET association being the main researcher and Masaryk University and Masaryk Memorial Cancer Institute in Brno being fellow researchers.

Prospective applications include the international research project in the area of neuroscience, BIRN (Biomedical Informatics Research Network), which enables access to high-performance models and brain

examination techniques. The Department of Neurology of the Central Military Hospital in Střešovice has already shown interest in becoming involved in the BIRN project via the CzechLight network. Negotiations on involvement in this project are underway with Thomayer Teaching Hospital and Motol Teaching Hospital.

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