UNIVERSITY COMPUTER NETWORK AND ITS APPLICATION FOR MULTIMEDIA TRANSMISSION IN MEDICINE

Otto Dostál, Miloslav Filka, Martin Petrenko

Otto Dostál
Department of Computers, Masaryk University
Botanická 68a, Brno, Czech Republic
Phone: + 420 5 41512215, Fax: + 420 5 41212747
Email: otto@ics.muni.cz

Miloslav Filka
Department of Telecommunication, Brno University of Technology
Purky ova 118, 612 00 Brno, Czech Republic
Phone: + 420 5 41149174, Fax: + 420 5 41149192
Email: filka@feec.vutbr.cz

Martin Petrenko
I. Gynaccolog. and Maternity Clinic of Masaryk University
Obilní trh 11, Brno, Czech Republic
Phone: + 420 5 42512111, Fax: + 420 5 42522121
Email: petrenko@fp-brno.cz

ABSTRACT

University computer network in Brno, the Czech Republic. Networks used for multimedia signal transmission. Further possibilities for increasing the transmission speed using WDM.

1. INTRODUCTION

The paper deals with the development of the university metropolitan computer network and the possibilities of furather increasing the transmission speeds even for the demandindg tasks of voluminous data transmission, i.e. mlultilmedia transmissions from the viewpoint of videotrasmission, transmission proper and picture data storage – Picture Archiving and Communicating Systém – PACS.

2. DEVELOPMENT OF ACADEMIC COMPUTER NETWORK OF BRNO UNIVERSITIES

There is a complex computer network operating in Brno, built and presently owned by local universities of the town.

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The building programme started in 1993 as a private network, connected through the Masaryk University Computer Centre with Prague and the world. The subscribers and members are connected by a 2.5 Gbit link supervised and directed by the Masaryk University Centre. Besides Internet services the network has a lot of other functions and helps to operate many different services. One of them is discussed below. The transmission medium of the Metropolitan network is an optical fibre. The routes in the town are either ground or overhead. To provide maximum possible reliability of the network most of the optical routes use circular topology. The optical cable is combined, it contains 32 SM fibres and 8 MM fibres. The reason is quite practical, the cost of active end elements of MM fibre is substantially lower. The transmission speed is 10 Mbits/s in case of applying the original Ethernet technology, 155 Mbit/s when the ATM technology is used; presently the G-bit technology is gradually installed.

The impulse to establish the NREN (National Research and Education Network) was prompted by the EC project named TEN-34 – Trans European Network interconnected at 34 Mb/s. The goal of this project was to bring Europe closer to the conditions in USA, where national T3 backbone for academic network exists. The proposal of the TEN–34 project was ready in 1994. In 1995 a consortium of 18 national networking oraganizations was founded, one of which was CESNET. The European backbone was realized in 1996. In the same year the TEN–34 CZ project was launched with the aim of building the Czech national backbone of the same speed as the European one. The first line of this backbone (E3 line Praha – Brno) was brought into operational state in December 1996, the rest of the backbone during the first half of 1977.

At that time the backbone was based on ATM technology.

In the years 1996 – 7 this technology was the only suitable technology for wide-area data networking.

The network includes all the universities with their faculties and departments, the institutes of the Czech Academy of Sciences, courts of justice, some offices of local authorities, business firms, as well as most of local hospitals and medical institutions if located on the optical route. At the moment the network consists of 50 km optical routes and 62 nodes each with its internal subnetwork.

As mentioned above, a part of the network is permanently reserved for medical data transmission and picture information. In the early stage of the project only two hospitals were interconnected and one type of "modality" (ultra sound in this case) was used. Successively, other local hospitals were connected with the modalities of their own.

3. PICTURE PROCESSING SYSTEM

For collecting, processing, archiving, and imaging, the PACS produced by Rasna Imaging Sytem (Italy) was bought; its hardware is based on SGI unix servers that are used as central servers in individual work-stations (of the same manufacturer) with the Windows NT operational system. The central PACS server enables archiving all types of medicine picture data, picture sequences included.

The central PACS server communicates via the computer network with various data sources, such as CT (Computer Tomography), US (Ultra Sound), XA (X-ray Angiography), MR (Magnetic Resonance) and MG (Mammography), using the DICOM (Digital Image Communication in Medicine) protocol and can obtain picture data from those modalities. The DICOM protocol enables also communication with a hospital info system (radiology info system) and acquires the necessary data of currently running procedures that may, if necessary archived in the database together with picture data. Of course, the central PACS is connected to client work-stations that take the information either by means of DICOM protocol or WWW interface.

The central PACS is formed by the Perceptive Archive SW product working over an Infomix (version No. 7) database. It is fully compatible with the DICOM 3.0 standard, through which it communicates with others and stores data in it, too. Thus the possibility of connecting any further institution capable of communicating in this standard is possible even independently of the manufacturer. The product guarantees total collection of data, archiving and administering them (via the Informix database), their retrieval and presentation in specialized client work-stations (DICOM 3.0 protocol) as well as through the WWW interface. All the data can be stored in Single Frame or Multi Frame (static or dynamic format).

The practical experience of PACS in hospitals led to a decission to create a system enabling simultaneous individual picture transmission following practically immediately the transfer of a patient from one hospital to another, on-line and time-delay consultations between experts in different medical branches not only on Brno but in nationwide and international scales. A possible parallel creation of a picture database for both the research and the teaching process seems very promising.

The system is very demanding and has to be an open one with easy accessibility for other medical intitutions from the region. A sufficient transmission capacity and subsequent reliability appear as seriously limiting factors. A solution would certainly increase not only the quality of diagnostics but also the medicare as such.

4.GENERAL PURPOSE

For this purpose it is necessary:
- to digitalize analog data from various sources (instruments) - creation of co called "modalities"
- to standardize digital data in the internationally valid format DICOM (Data Image Communication in Medicine).

In the case of more advanced instrumentation, the application of built-in hardware is assumed, which enables the DICOM format output
- to ensure archiving great volumes of data,
- to provide the possibilty of data processing (i.e.working with graphics and picture description, thus providing more accurate diagnostics),
- to provide communication between hospitals via a powerful network, giving the possibility of on-line or time delay consultations of experts in different hospitals,
- to provide for the instruction of students by creating databases of image data that could be viewed via the web interface
- to provide the possibility of holding videoconferences, joint seminars and workshops, live transmissions from operating theatres, etc.

5. SOLUTION PROBLEMS

To accomplish the objectives mentioned above, the following problems have to be solved as soon as possible:
- data reliability - data coding,
- access rights for individual entries,
- legislature
- technical problems of transmission speeds and memory stores.
- costs of certain components in the system,
- changing the style-of-work of hospital staffs
- a suitable structure of archived information enabling further processing (in case of creating the reseacrh and teaching systems).

6. INCREASE OF NETWORK TRANSMISSION SPEED

The inctreasing volume of multimedia transmission makes heavy demonds on arterial networks. This is the reason why wave multiplexes are considered for more extensive applications. Therefore, some parts of arterial network were measured for the quality and qunatity of both polarization and chromatic dispersion regarded as factors on which WDM introduction depends. Due to the composition of the arteries, which consist of specific sections, they were gradually measured and the resulting formula is

$$\mathrm{PMD} = (\mathrm{PMD}_1^2 + \mathrm{PMD}_2^2 + \mathrm{PMD}_3^2 \ldots)^{1/2}$$

Numerically, it is possible to obtain a dispersion of 1.3 ps enabling transmissions over 40 Gbit/s. Also the chromatic dispersion was measured within the range of the above mentioned speeds. Favourable values of dispersion result from the following formula

$$\mathrm{Disp} = (\mathrm{PMD}^2 + \mathrm{CD}^2)^{1/2}$$

7. CONCLUSION

The paper stated the unique quality of a private computer network in Brno – in the Czech Republic. Two simultaneously solved issues – the pictue transmission in medicine and the growing demands on the comlputer network quality were presented. The given example shows the preparation of information technology for medicine and the teaching process at the Faculty of Medicine. The feedback shows some technical possibilities of technologigal growth. The telecommunication and computer technologies thus contribute to the further development of scientific disciplines within the telecommunication field.

REFERENCES

[1] R. Sabella nad P. Lugli, „*High Speed Optical Communications*“ , Kluwer Academic Ppublishers, New York (1999).