On the possibilities of the interactive mode for the processing of medical data in the Grid-system for storing medical images

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Abstract. *Institute for Scintillation Materials, in collaboration with other institutions NAS and AMS, has been performed pilot project in order to create a Grid storage of medical images. This system is a step to the field of electronic storage of medical data. Extensive data quantity, its structure and distribution, the reliability and availability requirements is a challenge that GRID technologies can accept. The standard of medical information record is DICOM. This system can be used not only for the storage and processing of images, but also for the solution of statistical and epidemiological problems. Particular attention is paid to the possibilities of interactive processing of medical data accumulated in the system.*

Keywords

Grid, Medical Imaging, DICOM, Distributed storage

1 Introduction

In the diagnosis and treatment of physicians are increasingly relying on medical images. Medical images provide the bulk of information about the patient, but by themselves they are not enough, because they need to be analyzed and interpreted in the context of the patient's history. Although modern equipment allows to obtain medical images in digital form, retention, not produced in Ukraine. Medical patient data collected in different hospitals. Doctors often do not have access to all the medical history of their patients. Part of the image of one modality is not enough, because the imaging is affected by many parameters, and additional information is collected different data collection of physical data. These deficiencies must be overcome GRID system.

Institute for Scintillation Materials (ISMA) for the past 15 years carries out work in the field in the design and manufacture of scintillation diagnostic equipment for nuclear medicine. Currently in Ukraine nearly 90 percents of nuclear medical systems was designed and manufactured in the ISMA. Recent years ISMA is actively developing GRID cluster. At present it ranks second in the Ukraine by computing power. These two factors were a prerequisite for creating the storage of medical images using Grid technologies. The system is created in the framework of the State Science and Technology Program of Ukraine for the implementation of Grid technologies [1].

The system is currently being implemented at the M.M. Amosov Institute of Cardiac Surgery. Besides of simple accumulation of medical data, it is assumed as their active treatment, including real-time.

2 The Structure of the Storage for Medical Images

Grid technologies are used for projects that require more processing power and large data storage, working with geographically distributed information or requiring fast secure access [2]. Main resource for the created system is amount of distributed information and access speed. Grid infrastructure can provide geographical distribution, high security and access speed. Desired level of redundancy is provided in a distributed system that allows you to recover data in the fall of any of the nodes and increase the speed of data access.

Medical data are used in the diagnosis, with further treatment and therapy planning. Under the diagnosis medical images is usually visualized and interpreted by a radiologist immediately after receiving them before passing them to the attending physician for review. These two readings are usually shot in different rooms, and perhaps even in different buildings. With further treatment images can be attracted by other doctors, because the images obtained at different times, may be acquired in different radiology centers, and several doctors may need to read them. Medical images consists huge amounts of data: one image can be from a few megabytes to a gigabyte or more. General European trend is long-term storage (about 20 years for all the data and up to 70 years for some specific data).

Solution to the problem of data distribution involves a huge, multi-center integrated database. In order to overcome the statistical error in the study of indicators such as way of life or food, need a database, which can extend beyond national borders.

In the complex issues of grid applications in medicine stand alone question is PACS-systems (Picture Archival and Communications System, or PACS). PACS-system is defined to be specialized information systems, which are designed to handle large volumes of data radiological, genetic research and medical images [2]. Radiological examination information even for one patient can take large amounts, especially the presence of complex examination (three-dimensional images, time series, etc.) requires a description to suit different contextual factors and features. Thus, the primary information in the standard CT-scan can take tens of megabytes, and the MRI-scan up to a gigabyte. The number of such information are increasing continuously. Medical information also requires computer processing, scaling, and creation of structured archives. Today, the pictures as part of a medical document, do not follow the patient in the process of examination or treatment from a clinic to clinic, medical information scattered in the test area. In the treatment, as a rule, it is unable to complete medical information about a patient in a historical perspective. After the approval of standards for storage and transmission of medical information and the introduction of electronic patient records will be able to move from paper to electronic records of medical documents, which can be easily transferred from the clinic to the hospital after the patient. Access to this information must be limited, the data must be encrypted to ensure their safety, but the form of standardized clinical protocols should be clear to physicians regardless of the patient and the host country.

At present there is a distributed database and store of the images on the basis virtual organization MedGrid [3], [5]. The system includes:

- Interaction with medical offices module
- DICOM-parser for reading DICOM fields for further processing
- Data Storage for Images
- Database server for metadata
- Authentication Module
- Patient depersonalization module
- Web interface for physicians
- Administrator interface

Each doctor receives a certificate that allows to work with the system, to load research and view public data from other patients. The doctor only has access to research that has downloaded, or those linked him to other members of the system, or the patient. Doctor can work with the database using a regular Internet browser, but it is more convenient to use special access clients.

From the medical device data arrives to storage in the DICOM format [4]. For each analysis unique random ID or QR-code is formed to provide patients with access to their own analyzes in the future. Images and meta-information are separated by DICOM-parser. Images are stored in the repository in the form of files and meta-information goes into a database through patient depersonalization module. It filters DICOM-fields, and removes from them any personal information. Such fields are not stored in the database. In addition the depersonalization module destroys field of personal data from the structure of DICOM-file. After saving all public metadata with images in a new file, it is added to the repository of research. After uploading a file to the database the user receives a unique QR code for analysis (analysis ID). It can be used for finding the analysis in the database instead of personal information. Image with the QR-code is placed on the medical form of the study, which is issued to the patient. The QR-code form allows to scan ID easily and to identify study in the grid system.

3 Interactive mode

It is well known, Grid is poorly adapted for interactive user interface. This is due to the system job queues, which is an essential part of the Grid. On the other hand Institute for Cardio Surgery, where the implementation of the system take place, has the actual problems involving handling real time. Coronary angiography is one of the most invasive diagnostic procedures. To carry it out in the patient's artery catheter is inserted in the area of thigh. Then, the catheter is fed through the arteries to the cardiac muscle and X-ray contrast is injected through the coronary blood vessels. X-ray machine produces a series of images that show the progress of contrast through the vessels and vascular structure. There are cases where the injection made with a bad quality, or not in an optimal location. In this case, injection can be repeated without stopping the procedure. Unfortunately, the visual analysis of angiography during it can not always identify such a situation. Then all the invasive procedure must be repeated from the beginning.

Currently, the Amosov Institute researchers has developed angiographic image processing algorithms that evaluate their quality automatically. It may also be given advice about the necessity of re-injection and its location. These algorithms require large computational power and can be calculated in the Grid. However, these calculations have to be be implemented in real-time and interactive interaction with physician conducting the study.

In order to circumvent the limitation of interactivity we have proposed the following scheme for starting jobs.

Immediately after the registration of the patient for the procedure we put in a grid queue pilot process . During the preparation of the patient, placing and outting catheter pilot process is guaranteed to pass all the queues, launches child processes at all necessary clusters and, at the time of X-ray contrast injection reserves all the necessary resources.

The moment of injection may be either rough estimate on the time of registration and the average duration of preparations. Or can be calculated more accurately, if intermediate snapshots during the passage of the catheter through the arteries are transfered to Grid. In any case, immediately after the receipt of angiographical images,they begin to be processes in the Grid distributed.

4 Summary

Grid can be effectively used for storage and processing of medical data. This leads both to an improvement of the existing methods of diagnosis, and to the emergence of a fundamentally new opportunities. Grid storage system of medical images can be used to store objective medical information in the new unified national registry of patients. The problem of lack of interactivity in the grid can be overcome for many medical diagnostic tasks through the use of pilot processes.

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