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Automatic System for Medical Implants Based on the Grid Networks

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Abstract: - In everyday life man can be faced with various difficulties among which one can mention the fractures of the bone system. Various instruments called medical implants are used in order to treat such fractures. An implant is a new surgical instrument devised to meet the following: all technical, metallurgic, and biomechanical requirements, clinical usefulness. This paper presents the development of a thematic GRID network, on the existing infrastructure (communication and computer operations) and the completion and equipment of the software applications up to the level Tier. Also it sets out to develop, implement, test and improve an interactivity methodology of data processing applications (initial processing software, databases of comparative analysis, document processing), data acquisition equipment, but also specific processing and storage techniques within the GRID network.

Key-Words: networks, medical implant, database, software, trier, grid technology.

1 Introduction

The theoretical part of the Automatic System is based on AO classifications based on medical implants. The AO is a non-profit organization based on a network of surgeons who are committed to the study, practice and teaching of AO principles and their advancement in the field of trauma and musculoskeletal surgery. Founded in Switzerland in 1958 under the name of "Arbeitsgemeinschaft fur Osteosynthesefragen", the AO today represents the world's leading knowledge organization in osteosynthesis. The AO organization works together with industry in the areas of research, development, education and quality assurance in fracture treatment for the benefit of fracture patients. This Automatic System relies on the GRID technology and sets to develop the following informational chain: fracture occurrence, its location in AO standardization function of fracture X-ray, establishing the necessary implants, hospital supply with the necessary implants, designing and establishing the necessary technology for new implants.

2 The GRID Technology

The term "GRID technology" appeared in the mid 1990s and it designates a distributed calculus infrastructure which meets a wide range of computatational and storage requirements. The purpose of the GRID technology is to develop and coordinate the parting of the software and hardware resources among the network nodes. The resources parting means in so far as this technology is concerned distance access, via high speed connections, in any of the GRID network nodes. Thus, within this GRID technology any of the partners favoring the project can use all the computatational and storage resources offered within the GRID nodes. The resource parting does not represent only a file exchange but also a direct access to computers, applications, data, as well as other resources. This access is very necessary in various situations, problems, as well as in the development of problem solving and financial strategies, derived from industry, science and engineering. The common use of the resources is necessary and both the resource suppliers and the consumers control it at a high level; they define clearly and carefully what has to be parted, who has the right to part the resources and with whom, as well as the conditions under which the parting takes place. A group of individuals and/or institutions defined through such rules form a virtual organization. A virtual organization is made of individuals and/or institutions, it is governed by a set of rules that regard the resource parting conditions, the structures regarding the right to part, the parting network structure which is controlled by

both the resource consumers and suppliers and all of these represent the most modern form of organization. The most important problem that justifies the concepts of the grid is the common resources parting and the solving of a problem for the virtual, dynamic, multi-institutional organizations. The grid processing (or the use of the term “computatational grid”) uses the resources of several computers in a network, in order to solve a single problem at a certain moment. The grid processing needs a software program that divides and reworks the program sections on several computers. The grid processing can be regarded as a distributed processing for big-sized processing clusters or it can be regarded as a way of parallel processing within distributed networks.

It can be set off from the work stations network within a corporation or it can be used in public collaboration.

The GRID applicational network meant to be developed at the level of a first demonstrative nucleus in the current project has as beneficiaries organizations that are interested in the field of medical applications

Grid arhitecture can be thought of a series of layers of different widths [4]. At the centre are the resource and connectivity layers, witch contain a relatively small number of key protocols and application programming interfaces that must be implemented everywhere (fig. 1).

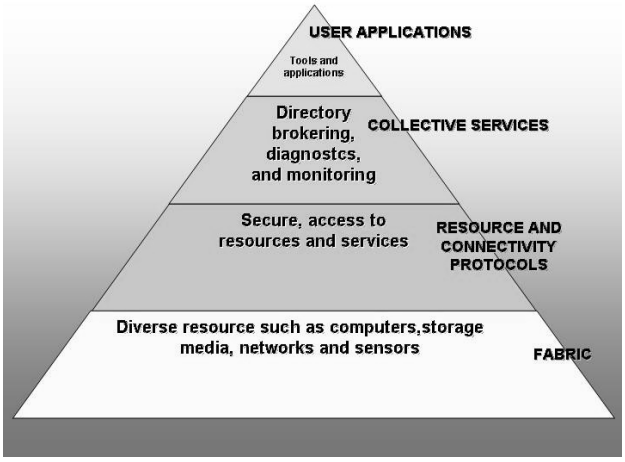

Fig 1

3 AO implant characteristics

The standard material for AO implants is stainless steel. AO introduced in 1965 a brand of stainless steel specially designed for implants and this contributed decisively to the international standardization of this kind of material used in bone synthesis. But nowadays Titanium is a material that will be used in future medical implants.

This Automatic System sets to develop a software program meant to allow, based on the X-ray fracture image, according to AO standardization [5], to classify the fracture within a certain group. Thus, depending on the chosen group and the type of bone the group of standardized implants and the desired implant will be chosen. The entire documentation necessary[6] for the implant designing technology as well as the technology necessary for the manufacturing of the implants will be developed by this automatic system.

The figures below show two types of fractures (fig.2) with the necessary implants (fig. 3) and the obtained results (fig. 4).

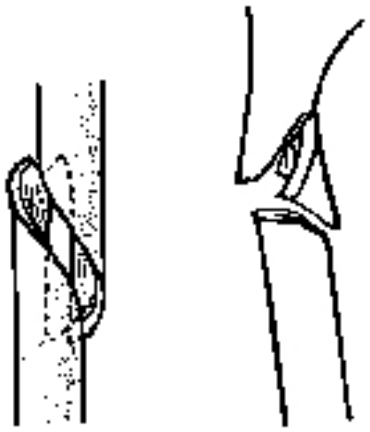

Fig 2

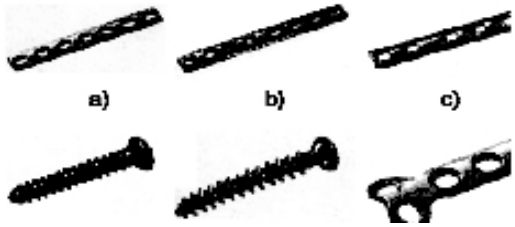

Fig 3

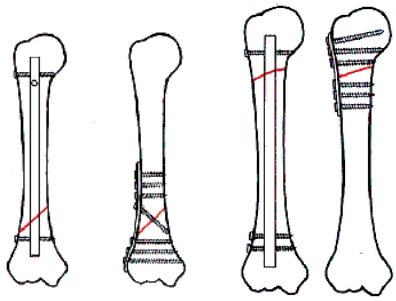

Fig 4

4 The Automatic System

The specific characteristics of the automatic system are:

- The development of an application network for medical implants design and administration function of needs, within the GRID technology, between present and future partners involved in this field;
- Expansion of the application network for medical implants design and administration depending on needs, by setting up access nodes compatible with the GRID technology for any of the partners involved and for other application nodes;
- The development of interconnectedness between the GRID nodes at a local, national and possibly international level;
- The development of the exploitation applications of the specific data for the medical implants design and administration depending on needs;
- Providing opportunities for a set of applications of public interest in a GRID technology;

The concrete objectives of this Automatic System are:

- The development of a thematic GRID network, on the existing infrastructure (communication and computer operations) and the completion and equipment of the software applications up to the level Tier.
- The development of two nodes for the GRID applications.

The partners of this system set out in the current system to build a GRID network which could be later on developed and connected to the GRID networks within the country and abroad. It will serve as infrastructure for specific applications whose specific purpose is generation, processing and interpretation of the data in the medical field and especially in the field of bone implants.

This system sets out to develop, implement, test and improve an interactivity methodology of data processing applications (initial processing software, databases of comparative analysis, document processing), data acquisition equipment, but also specific processing and storage techniques within the GRID network.

The software resources that will be developed within the GRID network consist of databases and data storage specialized in every partner's field of activity. Specialized applications will be built in order to use these data and they will consist of:

- Real time data acquisition applications;
- Offline and online databases and existing files applications;
- Distance databases inquires;
- Document management necessary in the development of implant technology

The partner represented by the Engineering Faculty contributes its IT&C expertise in the technical field and also in the academic "space" providing skills of an interdisciplinary nature and offering the IT support for the current project, the hardware and software programs for the development of the academic network node.

The partners represented by the Medical School and The Clinical County Hospital of Sibiu contribute by offering their expertise in the field of clinical telemedicine and critical medicine as well as a database that consists of real data of clinical record of patients under medical care.

The Automatic System carries out the AO documentation regarding fractures and implicitly implant classification. The Schema of this system is presented in figure 5.

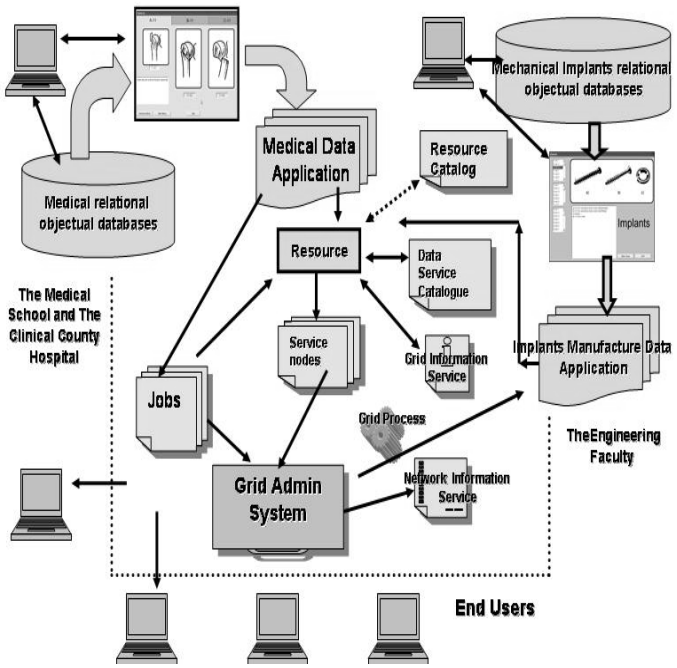

Fig 5

5 The Automatic System Arhitecture

The users in this system, by proxy, their applications which need to analyse this data to produce meaningful results. The users may want to investigate specific databases and may have specific application requirements that need not be fulfilled at every computational site.

In the Data Grid environment depicted in Figure 6, the steps involved in analysing distributed data are as follows. The application code [2] is the application that has to be executed on a grid. The users compose their application as a distributed application using visual application development tools [1]. The parameter model of creating several independent jobs is well suited for grid computing environments wherein challenges such as load volatility, high network latencies and high probability of failure of individual nodes make it difficult to adopt a programming approach which favours tightly coupled systems. Visual tools allow rapid composition of applications for grids while taking away the associated complexity. The user's analysis and quality-of-service requirements are submitted to the Grid Service Admin. The Grid Service Admin performs resource discovery based on user-defined characteristics, using the Grid Information Service. The Service Admin identifies the list of data sources or replicas and selects the optimal ones. It also identifies the list of computational resources that provides the required application services using the Application Service Provider (ASP) catalogue. The Grid Service Admin ensures that the user has the necessary credit or authorized share to utilised resources. The scheduler maps and deploys data analysis jobs on resources that meet user quality-of-service requirements [4]. The end user on a resource executes the job and returns results. The Grid Service Admin collects the results and passes them to the user. The metering system charges the user by passing the resource usage information to the automatic system.

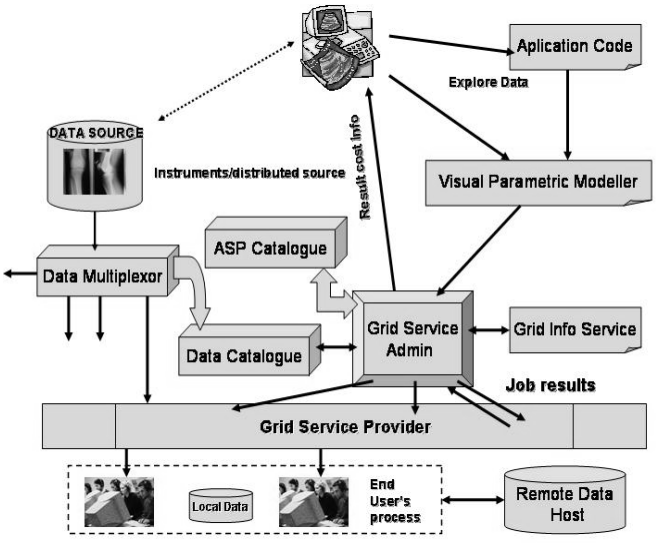

Fig 6

6 Conclusions

We have presented a Automatic System for executing distributed data between medical and mechanical domain on a grid. The system discovers computational and data resources, designed databases of system based on optimization of data transfer and returns results back to the user. The Automatic System strategy took into consideration the network conditions and has produced the best possible outcome by executing the jobs within the least amount of time. In the future we plan to developed this system with larger databases and multiple repositories for the same datasets. The applications for the interconnection of the two fields, the medical field and the mechanical one, are quite rare. Besides the process of automation, location, design and manufacture, the project sets to improve the fracture treatment processes of the bone system through IT technology. Also, in the future this system will be operational in other locations of the country.

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