

# NEW APPROACH TO DISTANCE LEARNING WITH USING OF GRID-COMPUTING

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**Abstract** - Development of high-speed, parallel and transputing calculations has become urgent demand in preparation of IT-specialists. Due to the financial support of HP Saratov State Technical University implemented a grid-node Information Technologies.

The project is aimed on the development of new academic strategy for creation and implementation at SSTU effective system of distance learning and development of corresponding hardware-software complex based on grid-computing environment which realizes the strategy with key stress on self-studies, innovations in lab and practical exercises. System of distant education gives students 24-hours access to electronic educational resources, possibility of complex modeling, data visualization. Implementation of grid technology allows students to study informational technologies which were traditionally taught at the universities labs only, to give them more flexibility in studying and at the same time provide teachers by the powerful instrument of monitoring students' progress (current and final). Using of grid-technology allows to save hardware and financial resources of the university in comparison with the system built on traditional platform. Using of virtual servers makes possible realization of multi-platform technology (combination MS Learning Gateway and HP Linux Red Hat).

There is described a software as a part of the distant learning system developed for the teaching of the course "Technology of Programming" which allows to study the basics of programming – methods of solving typical graph-tasks. The software consists of 3 parts: teaching of ways of graph-representation for searching of the shortest way in the graph as a typical programming task (realized by flash-animation technology); tutorial framework in which student can develop his own algorithms and study traditional algorithms as well; solving real large dimension graph-tasks by means of grid-calculations which are solving by the last year IT-students or by Ph.D. students (both realized by java-applets).

*Key Words* – Distant education, Grid-technologies, Multi-platform base, Technology of Programming.

During last years in the whole world there is increasing the interest to organization of various computing clusters and distributed grid-systems. It is connected with appearance of a cheap and accessible hardware for development of such systems. At the same time the creation of the software algorithms, which are available for parallel calculations in the active distributed systems, is a very difficult and urgent task. So, development of special programs for their using in the distributed systems is an important part of preparation of the modern IT-specialists. Many universities in the world have started MS program on grid-technologies.

Saratov State Technical University (SSTU) with financial supporting of Hewlett-Packard Company has organized a grid-node on the base of 4 HP Integrity 4640 Itanium Services which is used by engineering and research environment of Russia and nowadays is developing the educational complex aimed for training the students in the sphere of information technologies by means of grid-calculations.

The project has a target to develop a new educational strategy for its using in organizing and realization of a distant education system and a corresponding educational software for using of grid-node. This new educational system is aimed on organization of students' self-studies by means of distant fulfillment of labs.

The distant education system combines two technologies:

- Microsoft Class Server technology, which serves as a system for complex automation of an educational process;
- OurGrid project which controls the work of grid-node.

The opened architecture of Microsoft Class Server gives the opportunity to use the system for cooperation of methodologists, professors, students and their parents. The system also permits to organize and manage the educational curricula and corresponding teaching materials, to evaluate students progress, and to make reports about it. This report is available for everybody who has the access to the system: teaching staff, students and their parents. Besides that this system could be used as a consultation channel between the students and the teaching staff and fulfills the role of e-learning.

The elaborated system is web-oriented, it means, that all the processes in the system are carrying out through the Internet-browser. This approach allows to reduce the

necessity to install the special software on each PC which could be used by user. HTML-pages contain educational content (course theory in text and graphic formats including multimedia, references to the documents of other type and which are available to the user).

Unlike the other distant education systems, in which students are supposed to work without any assistance of the teacher only with theoretical materials, this new system offers the students to get some practical experience via Internet. In order to realize it there were developed Java-applications installed into html-pages.

The system was developed for the realization of the course “Technologies of Programming” for students of Engineer curriculum in Information Systems and Technologies and that makes the students to learn more about the main programming methods including methods of graph tasks solution. The mathematical models in form of graphs are very useful while modeling the variety of different phenomena, processes and systems. Many of modern theoretical and applied tasks could be solved by using of graph models.

Educational course “Technologies of Programming” contains of the set of HTML-files within the embedded Java-applets and flash-animation. HTML-documents contain theoretical materials. The main idea of the flash-animation is to demonstrate visually the work of methods and algorithms of the course. Java-applets give the students an opportunity to have practice in using the methods what could help them to confirm their theoretical knowledge.

There are three types of applets in the system:

- applets used for practicing and for examination of some particular knowledge;
- applets, represent the flexible educational environment in which the students could develop their own algorithms and programmes and investigate these algorithms (environment could transform developed algorithms into programming code in C or Java);
- applets aimed for realization of the algorithms and for solving of the real practical and research graph tasks which demand a lot of calculation resources and could be solved by using of grid-technologies.

There are a great number of graph tasks, which require very complicated calculations where complexity increases with increasing of number of graph nodes. These tasks cannot be solved on the user’s PC and they demand parallel calculations. The grid-node is used for solving these complex tasks, it has great calculation power itself and can use power of other grid-nodes which are situated in various parts of the world. Students can use grid-node for solving their tasks and improve their skills in using the distributed systems. Nevertheless, there is another problem, which is connected with the specificity of the grid-node using connected with realization of calculations by means of different processors and operating systems. Thereby it is necessary to take account of two key factors:

1. the difference between the productivities of processors requires an appropriate distribution of calculations between processors;

2. the difference between the processors structure requires the preparation of different executive files for different computers.

The first problem could be solved by OurGrid Technology. It is a complete solution for realization the Bag-of-Task applications on the grid-node. The Bag-of-Task applications are parallel applications which could be fulfilled independently. It means that there is no need to realize the tasks in some particular order. OurGrid Technology allows setting configuration of the resources (the number of computers or processors, their structure and productivity) at the time of the task processing. Therefore the programmer has an opportunity for manual set up of this resources configuration dynamically, without the recompilation of the source code of the program, which is executed on the grid-node. The programmer after setting the resource configuration started his parallel programs on the grid-node, not thinking about which, PC or processor will be used.

OurGrid Technology contains three main components: MyGrid, Peer and UserAgent. MyGrid is a central component of the technology. The main aim of it is to coordinate, control and plan the execution of the task and to distribute necessary data between computers that are united into the grid-node. Peer component gives addresses of computers with necessary configuration for fulfillment of the task. UserAgent is set on every computer of grid-node; it gives the necessary functionality to execute the task on computer on which it has been installed.

For solving of the second problem programming language Java is used. The Java code of the program isn’t connected with any concrete operating system or processor’s architecture. Java Virtual Machine (JVM) must have been installed on every computer, which could be used as a calculating element, which is called GUM. JVM gives the opportunity to execute Java-program on the concrete computer and in the concrete operating system. Nevertheless this approach reduces the productivity and brings additional expenditure of operational memory but it is the only way to develop the only programme for a great number of varieties of operating systems and processors.

Solving of a typical graph task by means of grid-technologies in the distant educational system is shown in figure 1 and can be described as following:

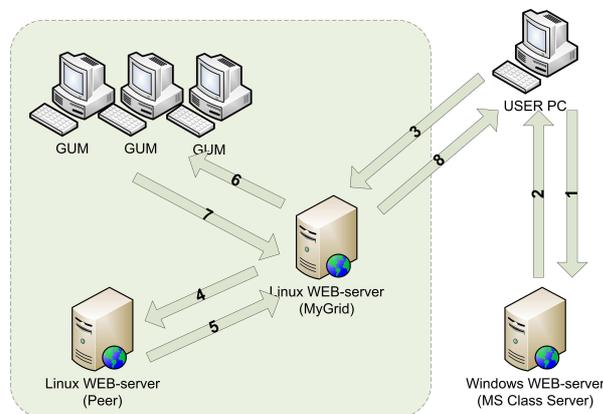


FIGURE 1  
EXECUTION OF PARALLEL PROGRAM WITH THE USAGE OF GRID-UNIT

1. A user has to register in the MS Class Server;
2. HTML-page that contains Java-applet loads on user's computer;
3. User inputs into applet initial data. The applet sends this data to MyGrid for fulfillment;
4. MyGrid makes an inquiry to Peer on getting a list of accessible computers able to solve the tasks;
5. Peer returns the list of accessible computers;
6. MyGrid chooses computers with proper resources configuration and transfers data necessary for the fulfillment of the task;
7. The results returned from the GUM to the MyGrid;
8. The results transfer to the Java-applets where user could get them.

The distant education systems give 24-hours access to electronic educational resources and to the software, which gives the opportunity for modelling and visual processes of the results of the modelling. This system allows IT- students to fulfill their laboratory works not at the university labs at the special fixed time for it but gives them an opportunity to work with the system at any time and place. At the same time this system serves as a good instrument for the teaching staff to manage students' progress. While working with the system students have a good chance to control themselves during all the periods of study according the course plan. So, using of the educational system based on grid-technologies allows to increase efficiency of education for IT-students and at the same time give them knowledge and practical skills in a new field of studies – grid-calculations.