Virtual Infrastructures in Education

Hristo G. Valchanov[1], Nadezhda S. Ruskova[2] and Trifon I. Ruskov[3]

***Abstract* – The traditional teaching method requires the students to attend classes. The classes are scheduled at certain time and in certain laboratory or seminar hall. All these conditions bring limitations in the teaching process. It appears not to be flexible and unable to react quickly enough to the rapidly changing areas of study like IT technologies. The usage of virtual machines and virtualization technologies will increase the capacity and usage of the existing infrastructure. Due to, the teaching will become more adequate to the rapidly changing world of IT industry. In this paper we present our approach for implementing a virtual infrastructure in Computer Science Department at Technical University of Varna.**

***Keywords* – Virtual infrastructures, Virtual computers, E-learning.**

I. Introduction

The traditional way of learning is based on the laboratory facilities used by students for practical utilization of the material. Such laboratory facilities in most cases consist of a number of personal computers, cabling and related network devices located in a specific laboratory. Each computer has a separate operating system and installed software according to the curriculum. In carrying out the laboratory exercises the students need to be physically present in the room at specific times. The quality of the conduct of classes requires the maximum number of students does not exceed the capacity of the laboratory.

All these conditions bring limitations in the teaching process. It appears not to be flexible and unable to react quickly enough to the rapidly changing areas of study like IT technologies. Changing the curriculum, both in theoretical and practical aspect, will bring the need of changing the existing laboratory infrastructure, and the software already installed.

Problems can be summarized in two categories. First, these are problems associated with maintenance of hardware and need to reinstall software and update the various courses. The large number of computers requires a laboratory and staff time to support this. By increasing the number of applications also grow and the need to increase the number of servers on which these applications run. This means that the cost of building and maintaining an IT environment will increase significantly.

On the other hand, it is possible to provide a PC for each student. Students will be able to fully carry out laboratory exercises, which reflects in the quality of their training. The limited number of school laboratories and equipment in them are reducing the opportunities for full deployment of training.

Solve many of these problems can be done by applying a modern technology – virtualization.

In this paper we present our approach of implementing and applying a virtual infrastructure in Computer Science Department at Technical University of Varna.

II. Virtual Infrastructures

Virtual computer is a logical representation of a computer using software [1]. By separating the physical hardware from the operating system virtualization provides greater operating flexibility and increased utilization of available hardware. Although virtualization is implemented mainly by software, many modern microprocessors include components specifically designed to increase the effectiveness of virtualization. In traditional physical computer there is an instance of the operating system serving one or more applications - Fig. 1.

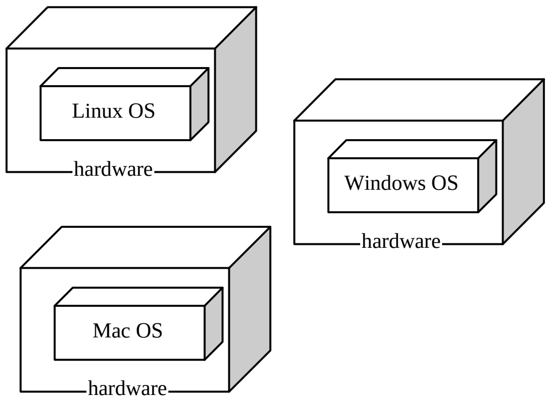

Fig. 1 Traditional computers

In virtual environments one physical computer is running software that represents the physical components of the computer as "abstract" and they can be shared between multiple "virtual computers" – Fig. 2. Each virtual computer can run a separate operating system (Guest OS) independently of other virtual machines within a physical machine. Failure or bugs in one virtual machine do not affect other virtual machines.

[1]Hristo G. Valchanov is with the Computer Science and Engineering Department at Technical University of Varna, Bulgaria, E-mail: hristo@tu-varna.bg

[2]Nadezhda S. Ruskova is with the Computer Science and Engineering Department at Technical University of Varna, Bulgaria, E-mail: ruskova@tu-varna.bg

[2]Trifon I. Ruskov is with the Computer Science and Engineering Department at Technical University of Varna, Bulgaria, E-mail: ruskov@tu-varna.bg

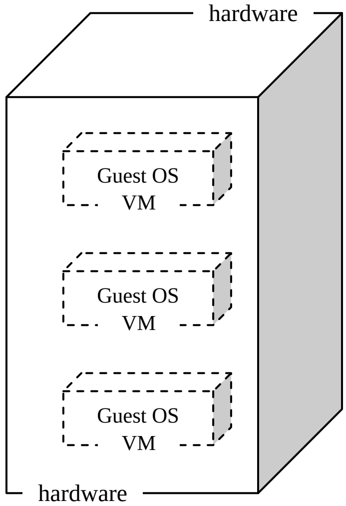

Fig. 2 Virtual server model

Virtualization can be implemented in two directions: desktop and server virtualization.

Desktop virtualization transfers the operating system and it supported applications from student computer to a server. Each user can set his/her desktop environment. But unlike the work of a single computer when moving to another student in another lab, its desktop environment is the same regardless of the currently used workstation. If the used computer is damaged, the student's desktop environment is available at any workstation on the network.

Server virtualization, also known as *virtual infrastructure*, allowing on one physical server to run multiple virtual servers [1],[2]. The result of the virtual infrastructure is a significant reduction in maintenance costs of equipment, balancing the load of computers, flexibility in the management and adding new applications. If the resource requirements of applications running on the virtual server grow, moving the virtual server to another more powerful physical machine is extremely simple form of copying files.

One of the most popular software for building virtual infrastructures is VMware ESX Server 3 [3]. The choice of VMware Infrastructure 3 is dictated by its capacity for multi-processor support, dynamic balancing and allocation of resources between virtual machines and migrating virtual machines between servers without interrupting their work.

III. THE GOALS

The main goal is by virtualization of the infrastructure, combined with mobility of the learners, to increase the efficiency of the teaching process and the research capabilities of students and lecturers. With the achieved flexibility, the teaching will become more adequate to the rapidly changing world of IT industry. The usage of virtual machines and virtualization technologies will increase the capacity and usage of the existing infrastructure, and it will ease its administration.

The virtualization will avoid the need for redesigning and reconfiguring the hardware and software in the laboratories, when changes in the curriculum occur. With the virtual infrastructures it would be possible to use simulation tools to analyze and investigate real systems and processes. To build this, without the mentioned technology, a significant amount of expenses will be needed. Changes in the curriculum will lead to logical configuration of the virtual infrastructure, in form and structure corresponding to the new requirements.

Using the mobility by notebooks, the students will not need to attend the university halls to complete their practical classes. This will give them the possibility to plan their students' activities in their own way and style. Also, as a result, the students would be more interested in the learning process. On the other hand, this system will let the lecturer to have a complete view on the students work, and their achievements.

As a result, this would give the opportunity to implement *Anyplace Anytime Learning* (AAL) in higher education.

IV. IMPLEMENTATION AND RESULTS

A. Implementation

The virtual infrastructure (Fig. 3) is built based on two server machines Sun Fire V20Z, connected with 1G Ethernet network and running Linux operating system. Over this operating system the VMware ESX Server 3 are installed.

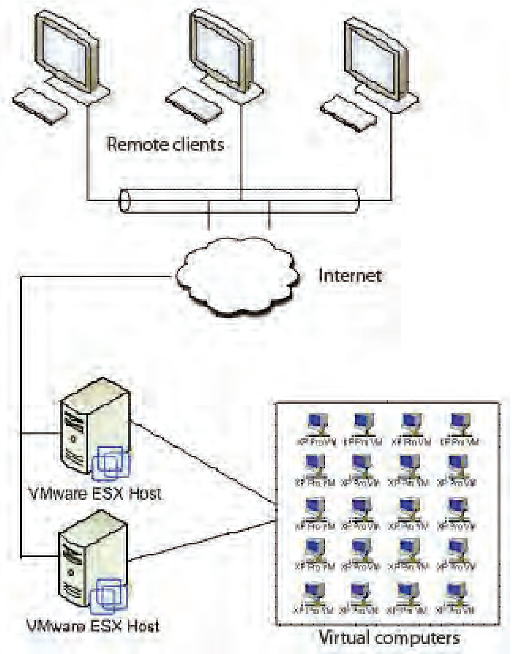

Fig. 3 Virtual infrastructure

B. Parameters

Planning the virtual infrastructure is made based on analysis of requirements for laboratory facilities to conduct laboratory exercises on the different courses such as "Operating Systems", "Compilers", "Distributed Programming" and "Network Infrastructures". Characteristic of these courses is that classes are conducted in the same laboratory. Different operating systems and application software are used. In Table 1 the data associated with these requirements are shown:

TABLE I
PARAMETERS OF THE LEARNING PROCESS

Course	Number groups	Number students	Work places	OS
Operating Systems	8	15	8	Linux
Compilers	8	15	8	Windows XP
Distributed Programming	8	17	8	Linux
Network Infrastructures	3	12	8	Windows Server 2003

As the table shows the number of desktop computers is insufficient for practical exercises for all students. This is a problem that inevitably leads to incomplete mastering of the educational material.

The second problem is that there are required different operating systems for different courses. When using stationary desktop computers these operating systems could to be installed on separate partitions on hard disks, but experience has shown that this leads to serious difficulties in their reinstallation. This is situation because of frequent failures in the system caused by the work of students with administrative rights, viruses, etc.

C. Measure approach

To measure results we introduce the following approach. For those students, participating in Anyplace Anytime Learning (AAL), a baseline at the beginning of an academic year was defined. Various data and information about the learning process were kept, such as: consumed time for preparation of classes, number of projects assigned to students, number of practical tasks prepared by students, number of practical classes, results and marks achieved by the students.

This information was gathered as feedback, by the lecturers and tutors during the semester. Based on this data, at the end of each academic year a statistical analysis was created.

D. Results

After deployment of the virtual infrastructure of each student is given the opportunity to work on a personal virtual host. Using X-windows terminals (thin clients) allows reducing the cost of laboratory equipment. There are many benefits to use thin clients.

With no hard drive, fan or other moving parts, thin clients have a much longer lifespan than standard computers and use significantly less power. Unlike a traditional desktop or notebook computer, no applications or data are stored locally on the thin client. This makes them easy to replace if lost, stolen or damaged. Unlike a traditional desktop or notebook computer, no applications or data are stored locally on the thin client. This makes them easy to replace if lost, stolen or damaged.

Deployment costs are also reduced as thin clients can be remotely configured and do not need to be set up individually. Significantly the reconfiguration of work on computers is reduced.

In addition we give the opportunity for the students to have remote access to virtual machines.

As a major positive impact from the implementation of virtualization, however, has made increasing the completion of tasks for the realization of students. The ability to remotely access virtual infrastructure resources allows students to work not only in laboratories but also from other places.

On Fig. 4 the evaluated results for the experimentally involved courses are shown.

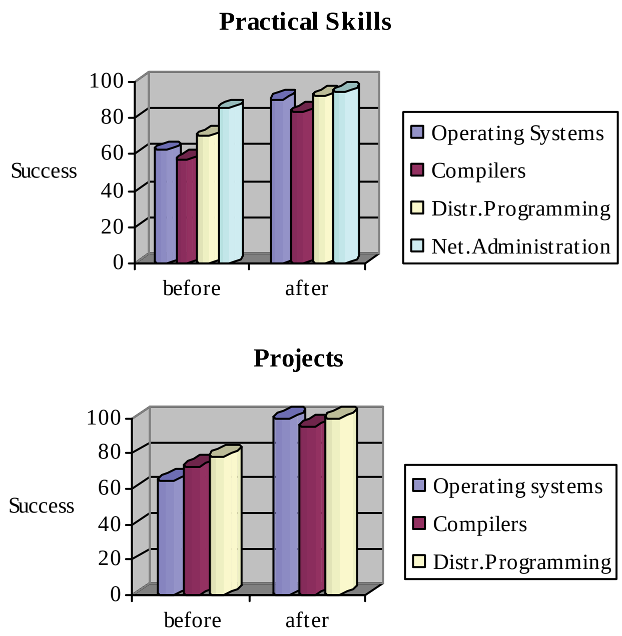

Fig. 4 Summary results

There is represented the percentage of success in terms of "practice skills" and "coursework". The courses have different improvement, which is a consequence of their specific matter. The improvement is more significant in courses mainly related to programming such as “Compilers” and “Distributed Programming”.

As a result, the utilization of laboratory exercises increased to 95% on average. In comparison, before applying the new approach, success due to the delay of the students work was on average about 65%.

V. CONCLUSION

In this paper the virtual infrastructure for student education is given. The main goal of our work is to combine the possibilities of the mobile communications and virtual infrastructure in order to improve the teaching quality of the higher education. The integration of the virtualization and the mobility will provide unified methodology for teaching different subjects in the field of the computer science [4].

Using the mobile computers will make the classes flexible. The classes will depend less from specific equipment, location, and time schedule. Beside the mobility of learning, other benefits for the students from this new way of teaching will be: ease in exchange of ideas and materials among students and lecturers, quick access to teaching materials, effective usage of the network infrastructure. This approach will also promote the research activity to the students.

Objective of future work is the building of virtual laboratories. Virtual laboratories allow build a separate computer environments for each student. This enables students to access applications that can not install or have on their PCs. Virtual laboratories allow access to laboratory facilities at any time and from any place, something that would enable all students to perform practical sessions remotely. With the help of Web interface, the students will be able to access the real equipment in the laboratories. Also, the simulation software will let them make their research, without attending the classrooms. This will give the opportunity to achieve better usage of the existing university network.

By thus achieved mobility training is expected to raise interest of students to learning and to research. The project will improve the university teaching methodology, will bring new learning techniques and will enrich the experience of both students and lecturers.

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REFERENCES

[1] I. Rozenfeld, *Server Virtualization*, NW City Technology Forum, 2007.

[2] D. Marshall, W. Reynolds. *Advanced Server Virtualization*, Taylor & Francis Group, LLC, 2006.

[3] VMware Virtual Infrastructure 3. http://www.vmware.com/technology/virtual-infrastructure.html

[4] HP Innovations in Education Worldwide Summit, San Francisco Bay Area,CA, 2010 http://www.istevision.org/postergallery.php