Approach to Solving of Decrease in Disproportion Between Groups of Students

Martin Novák, Jiří Křupka, Pavel Petr
Institute of System Engineering and Informatics, Faculty of Economics and Administration, University of Pardubice, Pardubice, Czech Republic
martin.novak@upce.cz, jiri.krupka@upce.cz, pavel.petr@upce.cz

Abstract

In this paper a problem of decrease in disproportion between part-time and full-time students is presented. It was solved by way of a virtual laboratory. The lab was created within the solution of the project named Virtualization. It represents the part of the decentralized program No. 3 The development of modern equipment and technology at the University of Pardubice in 2011, is sponsored by the Ministry of Education, Youth and Sports in the Czech Republic. The aim of the project Virtualization is to eliminate the disproportion of free access to licensed software between part-time and full-time students. Based on analysis of virtualization possibilities the solution has been implemented through Microsoft Terminal Server. A dedicated server with needed licensed software was installed. Students can connect this server and get remote desktop. Students can run installed software on the server’s remote desktop as if it was on their private computers. Therefore students can solve specified problems anytime and anywhere, if the connection to the Internet is available. After a very short time of using the virtual laboratory we can say, that the students’ skills in using the licensed software have been broadened as well as knowledge of part-time students.

Keywords
Education. Distance learning. Virtual private network. Virtual lab.

Introduction

Virtualization has become the real social phenomenon. However, using the word ‘virtual’ should be used carefully. For instance, Ivan M. Havel mentions: ‘... The only problem – generally said – I can see is that mechanization, digitalization and virtualization of our life is coming quicker than it is salubrious.’ (Cvek, 2005). In spite of this the word virtual has become ordinarily used in education, particularly in the field of distance learning (El-Bakry, Mastorakis, 2009) and e-learning (Doulgeri et al., 2006). Mentioned forms of education contribute to the development of the educated society, which meaning is confirmed in European (the i2010 strategy) and national documents. As we can see, it is a very important theme from the realized 3rd year of international scientific conference called Educated Society – Science and Education in the 21st century, which was organized by the University of Finance and Administration in Prague, the Academy of Sciences of the Czech Republic (CR) and the Masaryk University in Brno (10th March 2011). The conference was held under the auspices of the Prime Minister Petr Nečas and dealt with scientific and educational pieces of knowledge and their usage in drafting the higher education at present days.
In distance learning there are the constructs like virtual learning environment (Zounek, 2009), virtual lab (Casals-Torrens, Bosch-Tous, 2010; Drigas et al., 2005), virtual class (Drigas, Koukianakis, Glentzes, 2005; Kvřetoň, 2005; Michailidis, Margounakis, Politis, 2005) or virtual University (Průcha, 2003). Virtual learning environment (online learning environment) is possible to define as a technology (hardware and software (SW)), which is used for online learning pursued out of the traditional classroom (Mason, Rennie, 2006 quoted in Zounek, 2009; p. 122). In case of virtual labs we meet the constructs such as: iLab (iLab, 2011), online lab (onlineLab, 2011), virtual lab (virtualLab, 2011), web lab (webLab, 2011), web virtual laboratory (Smutný, Farana, Smutný, 2005) etc.

The primary reason for realization of project Virtualization at the Faculty of Economics and Administration (FEA) was to make licensed software accessible for part-time students.

At FEA isn’t any dedicated course to the virtualization. Basic principles of virtualization are discussed during lessons of Computer Networks (CNs) and Operating Systems. Students will meet practical usage of virtualization in lessons of CNs. In this course are virtual machines used as complete independent computers for teaching basics about settings of computer networks and network operating systems. These completely independent virtual computers are used at labs computers to avoid any harm or incorrect setting of hosting operating system of lab computer (students of another courses needs to have perfectly working lab computer, not some testing computer with wrong setting of operating system). For realization of virtual computers at student’s labs computers are used Oracle VirtualBox. Due to this desktop virtualization every student has full access to its own virtualization environment and virtual computers. Virtual computers are used during whole semester, therefore students will learn every basic aspects of virtualization.

Within the study programme System Engineering and Informatics (bachelor’s and master’s degree) at FEA, full-time students process tasks in their seminars in the computer labs. These are assigned in different licensed SW, e.g. MATLAB. Part-time students have the same conditions for gaining the credit, so they process same or similar tasks. Within the part-time studies however, number of hours spent in the labs per term (usually 5 hours) cannot be compared to the number of hours spent there by full-time students (usually 28 hours).

The aim of the planned solution was to cancel the disproportion in access to the licensed SW between the full-time and part-time students and of course allow the part-time students full access to the used SW.

Problem formulation

There are many ways, how to allow students the access to the licensed SW, e.g. Figure 1. The left column shows the environment of the University (University), communication channel (Internet) and students’ personal computers (Students). In the picture there are 3 possibilities of licensed SW distribution for the students. Most of the possible solutions are for the end user (student) very complicated and require certain network knowledge. For instance installation of the licensed SW directly to the student’s computer is not possible, because the students themselves must after installing the SW also set the school license server. And this activity is not suitable for an ordinary educated computer user.
Another possible way is to provide students the installed SW on the virtual computer. Student would only download the image of virtual computer harddrive (Virtual HDD), which would be used for start of the virtual computer in common desktop virtualization environment, such as Windows Virtual PC (it is part of Windows 7), then also Sun VirtualBox or VMware Player (both solutions are accessible free of charge). Overall SW and needed settings for getting the licence from the university’s licensed server would be the part of distributed virtual computer. Licence to operating system (OS) Windows for students is part of the program Microsoft Developer Network Academic Alliance (MSDN AA). One disadvantage is that there is a necessity to distribute a complete OS Windows, which usually means the usage of 5-10 GB of data. Another disadvantage is that there is nearly no possibility to update SW or OS remotely, or to change their settings. Distributed virtual computers would be completely under the end user manage, without the possibility of remote maintenance.

The last mentioned way is our planned solution, via Terminal server.

In the past we solved this problem via allowing licensed SW MATLAB by proposal and analysis of application in MATLAB Web Server (Galčík, 2008). MATLAB Web Server (Galčík, 2008; Hamar, P., Kropík, P., Šroubová, L., 2003) presents the possibility of the Internet communication between MATLAB and the user.

In application (Galčík, 2008) it is necessary: to set Apache HTTP server, create the input and output forms in HTML code and M-files examples in MATLAB, prevent making mistakes from the users’ side (students). An example of application window is shown at Figure 2.
The advantage is the remote access of the students to the licensed SW, but the disadvantage is a laborious proposal of HTML forms and M-files for solved examples made by the tutor. Another disadvantage for the students is that there is the possibility to solve the solely defined assignments and their solutions.

Proposal and solution testing

The most advantageous solution for testing was the terminal server at OS Windows Server 2008 R2. At this server there is a necessary SW used in the lessons installed. Now, there is MATLAB R2011b and Statistics 10 installed. Performance of the server is designed to 100 simultaneously working users.

Students have the possibility to connect easily to the remote desktop of the server. At the desktop there are the icons for the program start, which are installed at the server. After the
program starts, the student can work on it without any limits as if the program was started directly at their computer.

For connection to this server, there is a simple program needed. It is either part of the student’s OS or accessible free of charge. To the remote desktop of the server the students can connect from OS Windows (e.g. program Remote Desktop Connection, which is part of OS), from Linux OS (e.g. program rdesktop, which is either part of Linux or accessible to download) and it is possible to connect also from Mac OS (e.g. program Remote Desktop for Mac, which is part of the Microsoft Office set for Mac or is accessible to download free of charge). Thanks to the possibility of connection from nearly any desktop OS, it is also solve the problem with availability of needed SW for lessons to any OS, which student’s use on their computers.

After starting program Remote Desktop Connection for connection to the server, the students only enter the server address (fes-st01.upcecebny.cz). They can also set, that they want to connect any of their disk drives or a printer to this server. At this disk drive the students can save the example assignment or source data. It is also possible to write into this disk drive, which means that the solution would not be stored only at the server. After connection it is necessary to log in to the server, which will be done via student’s NetID and the password. The server is accessible for all the students and tutors of FEA at the University of Pardubice (UPCE).

There are no limits yet, e.g. access only for the students of the specific field or time limits, when the application in the server would be accessible only during the night or at the weekends. It is possible to access the server at any time from the University computer network. If the student is connected to the Internet out of the University network, the server would be accessible after log in to Virtual Private Network (VPN) of University. The students log in to the VPN also via their NetID. The client for the VPN connection is also accessible for all three above mentioned OS, i.e. Windows (Windows 2000, Windows XP, Windows Vista, Windows 7), Linux a Mac OS.

Figure 3 shows user’s connection from home via VPN to the terminal server from the OS Windows XP via program Remote Desktop Connection. At the virtual desktop there is MATLAB running, where the simple example is shown. The window with the remote desktop is possible to maximize at the client’s side (student’s side), which means that the work on the virtual computer is not disturbed by double Start icon (at the local student’s computer and the server’s). The remote desktop can be widened over the whole screen provides nearly same comfort as if the students sit at their computers in the classroom.

Naturally to have the access to the remote desktop, within this project, the students’ computers must be connected to the Internet. The minimal speed of the Internet connection is 128 kbps for work in the virtual lab. For a comfortable work with the virtual lab the optimal speed of the Internet connection is 512 to 1024 kbps. This requirement is accomplished by most of the commercially provided Internet connections in the CR.
Figure 3: Remote desktop connection to virtual lab in Windows XP.

More important factor than the Internet connection is actually response time (between the students – computer games players called as a ping). The response time is neatly connected to the connection speed, but it is possible to have high speed Internet connections with very slow response time. The response time is the time, when the user gets the response to his request. It means when the user requires downloading a file from the Internet server, the response time is the time, when the actual download starts. Nowadays the Internet servers are very powerful and quick, so the most limited factor is just the quality of the line, which the user connects the Internet with. Considering the work with graphic user’s environment of the OS, the interactivity of the environment is necessary (the graphic environment must react quickly to the user’s requirements), the response time is a key parameter for the user friendly work with the remote desktop. The suitable response time is therefore 10 to 20 ms, maximum 50 ms, for the problem-free work with the remote desktop. Higher response time will be shown as slower response time of the remote OS to the user’s actions (clicking the mouse etc.). The user then thinks, that the remote OS is slow and cannot manage the requests quickly enough; this can be compared to the work on the older and less powerful computer. There are no more serious failures and cut offs, when there is higher response time, only the comfort of using it is lower.

If the user’s (student’s) connection to the Internet was low-quality, there would be failures of the connectivity (mainly at the Wi-Fi network in the highly interferenced areas), this problem appears as so called image pixelation (very usual at television broadcasting in DVB standart), or by the frozen image. In case of a complete cut-off of the Internet connection, at the first frozen image appears, and then will be the disconnection of the remote desktop. However, at the server there will stay the running programs. If the student logs in to the server soon after the disconnection, the sessions will
be recovered and all the programs will stay in the former state. Within the saving of the server resources and licences of the terminal server, the users’ (students’) disconnected sessions will be automatically closed after some time. This setting has proved to be the compromise between the used licences and server’s performance on one side and the user’s comfort on the second.

The server itself is run as a virtual computer (Novák, 2012) within VMware virtualization environment of the Information Centre (IC) of the UPCE. IC keeps this virtualization environment running, so after the end of this project there will not be any additional operating costs to keeping it running. Virtualization of this server brings many other advantages, such as e.g. very easy back-up of the whole device, which is possible to be done during its running state. Also very easy transfer of the virtual device to any other physical server (when there is a breakdown) and another advantage is that – in our purpose the most interesting one – its easy change of the virtual device performance. The change of the performance can be set dynamically (i.e. the higher load of the virtual device is the more resources of physical device is assigned), or the change can be done manually, if the server cannot operate requirements of all logged in users in a reasonable time. Currently 2 processor cores AMD Opteron 8220 and 48 GB of RAM memory are assigned to the virtual server.

Performance and memory of the virtual device was consulted with experts to MATLAB from the firm Humusoft and with experienced terminal server administrators. The experiences gained, while testing this solution at the low powerful servers and desktop computers, were also taken into consideration.

There are synthetic laboratory tests, how to test the load of the server, so called stress tests. All these tests are documented in detail and can be repeated, but only in the more or less similar conditions to the real. Due to the fact, that the simulation of the real environment of teaching is very difficult and the data gained by the synthetic tests would not be very relevant, the testing in real environment was proceeded. Testing was done during the lessons, when to the selected number of students was given an example assignment, which was then solved at the tested server. The load of the server really corresponded to the real conditions, which this server was designed for.

The results of the stress test of the server with the licensed SW needed for the lessons at the server are mentioned in the Table 1.

Table 1: Results of stress test of the designed virtual lab.

<table>
<thead>
<tr>
<th>Processor</th>
<th>CPU Cores</th>
<th>RAM</th>
<th>No. of Users</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMD Opteron 8220</td>
<td>1</td>
<td>16 GB</td>
<td>30</td>
<td>Unusable slow</td>
</tr>
<tr>
<td>AMD Opteron 8220</td>
<td>2</td>
<td>48 GB</td>
<td>70</td>
<td>Quick responses</td>
</tr>
</tbody>
</table>

There were several tests done with different number of users and different configurations of the server. For instance server with 16 GB memory RAM and one assigned core processor AMD Opteron 8220 was already insufficient when 30 users work simultaneously. The most demanding test was done with 70 simultaneously working users in MATLAB and with server configuration: 48 GB memory RAM and both cores processors AMD Opteron 8220. The server persisted in this test and the work in MATLAB was fluent enough.

Other possibilities of development

Due to the server’s stress testing during the lessons, information about the existence of the server has spread among the other students very quickly. Currently there are many students, who already use this server to process the assignments. The server is accessible for students of both forms of studies (i.e. full-time and part-time) therefore also students of full-time studies can try the work in the program, which are used during the seminars. Many students like this form of using the
licensed SW from everywhere, and it resulted in requirements for the other programs used at the lessons to be installed to the server. The most required is the program ArcGIS, the program used at graphic information systems. ArcGIS is already included in the list of the other SW, which are being planned to install to the server.

Within the other development of the project the other licensed programs are also planned to be installed. Basically, the overall SW used for teaching could be installed there. The only problem is the lack of licences. Already installed SW uses the licences, which were bought within this project and are not used during the lessons. These licences are accessible 24 hours a day. The other SW licences are very often needed for teaching in the lessons, so they could not be provided during this time. It will be necessary to realize the solution, when the licences for these SW will be accessible at the terminal server only at the time apart from the school lessons.

Naturally, the other testing would have to be done, if the other SW does not overload the terminal server and if there was a necessity to make the higher performance and amount of memory RAM or disk space. In case of overusing the server resources, it would be necessary to use the unpopular limitation - FUP (Fair Use Policy).

**Conclusion**

The aim of proposed solution of the virtual laboratory, to make licensed SW needed for the lessons to the students accessible, was gained. All the students of the FEA UPCE have now programs MATLAB R2011b and Statistics 10 accessible at the terminal server. Via logging in to the server the student will get the remote desktop. At this desktop there are icons of each program, which are installed to the server. Starting the required program from the server, the student will get full access to the programs needed for their studies.

During the testing there were no problems appears. The terminal server is in full operation now. The students have a description and a simple manual how to connect to the server and how to process the assignments, projects and the sources for their thesis.

SW needed for connecting the terminal server (virtual laboratory) is commonly accessible for OS Windows, Linux and Mac OS and it is free of charge. The students can also set access to their selected disk drives, where it is possible to store the data and assigned tasks at their computers.

The terminal server is accessible directly from the University’s network (direct connection), or anywhere from the Internet (it is necessary to log in to the University’s VPN and then log in to the server itself).

The speed, performance and capacity of the server is rated sufficiently to the current requirements to the number of users, installed SW and also for the chosen OS including running services in this OS. In case of the lack of performance of the server in the future, it can be made upgrade easily thanks to the chosen virtualization technology. Just due to it, the results of the project are permanently sustainable also with the other development.

Improvement of learning, knowledge and practical skills has been evident from results of examinations, too. It is true; it was very short time in this semester (approximately two months) when it was made given software accessible to students. For all that better results have been demonstrable and improvement has been from 15% to 20% per subject by tutors.

Response of part-time students has mainly been very positive. They have found main contribution in improvement of learning, saving of time and finance. They had to report to school and to verify theoretical knowledge at practical assignments in computer labs during previous
semester. In regard to their workload, it was very complicated and time consuming. Anyway it was complicated for tutors because they had to be at workplace at the weekends, too.

In the following time period it is supposed this way of learning (to give access to other software, except MATLAB, IBM SPSS Statistics and IBM SPSS Modeler) to part-time students in other subjects, too.

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