SCENARIOS FOR CARRYING OUT THE COMPETITION IN INFORMATICS WITH SPECIFIC OUTDATED HARDWARE

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ABSTRACT

Competitions in informatics are usually synonyms for algorithmic programming contests. A lot of programming contests in the world use automatic grading of the contestants' solutions. Contestant should be able to upload the programming code as a solution for a given problem that he/she produced on a specific computer environment, real time.

In this paper we present the problem of providing the right hardware for carrying out the competition, and discuss the possible solutions while using obsolete hardware.

I. INTRODUCTION

In the past thirty years competitions in informatics are usually synonyms for algorithmic programming contests (other types include architecture, design, development, specification, assembly, testing scenarios, etc…). Many programming contests in the world use automatic grading of the contestants' solutions. This is accomplished by running them on batches of input data and testing correctness of the output.

Contestant should be able to upload the programming code as a solution for a given problem that he/she produced on a specific computer environment. It should be done real time (while the contest in running).

Competitions in informatics have a long tradition in Macedonia. There were XXII national contest cycles till the end of 2011. After number of competitions on national level, the best contestants represent themselves and Macedonia at IOI – International Olympiad in Informatics, BOI – Balkan Olympiad in Informatics, and JBOI – Junior Balkan Olympiad in Informatics.

The popularity of the competitions impinges attending of more contestants each year.

This affects the end phase of the competitions where we need to have them all in one physical location, which demands strong infrastructure.

II. AVAILABLE HARDWARE IN SECONDARY SCHOOLS IN MACEDONIA

The easiest way to organise the competitions is to use the existing infrastructure of the secondary (high) schools because they have a substantial number of computers. The high schools in Macedonia have a specific infrastructure based on the terminal technology made from Ncomputing [1]. This means that in one classroom there are 5 standard PC machines on which the X300 extension cards are installed. Every host has 6 additional terminals - a system of 1 host PC and 6 terminals. Cumulatively, in every classroom there are 34 working places.

Every working place provides Ubuntu Linux Operating System, with a set of educational tools (Edubuntu).

Another benefit is that all high schools in Macedonia already have ADSL Internet connection which will allow easy access to the platform for competitions - MENDO [2].

III. SPECIFIC REQUIREMENTS FOR THE COMPETITIONS

Well organized contest in informatics, should provide a working machine, with accompanying software for every contestant. A good working environment include Integrated Development Environments for programming languages used in the competition (Pascal, C, C++), easy access to files and continuous connection to the contest server MENDO (mendo.mk) containing the tasks, and the complete grading system [2].

IV. POSSIBLE SCENARIOS FOR CARRYING OUT THE COMPETITIONS

Here, we analyse three possible scenarios for the problem of providing the right hardware for carrying out the competition. We simply name them Linux, Windows and Cloud.

A. *Linux – (let's use the existing machines)*

On the existent infrastructure, as a choice of the Ministry of education and science in Republic of Macedonia and the Ministry of Information Society and Administration, the Linux operating system is preinstalled (Ubuntu v.07.04 with outdated software packages). With the use of such hardware, to supply an up to date environment becomes challenging task. That is mainly because, like all the other packages, the main libraries are out of date.

Updating the OS is not possible due to hardware restrictions. The X300 extension cards driver consists of two modules, one of which has a virtual X.org module that works only with the installed version of the X.org. If we make an update (distribution upgrade) or install a newer OS of the same family it will have a newer version of the module X.org. The existent (installed) driver only works with kernel up version 2.4. That is why we concluded that the system must remain with Ubuntu Linux version 7.04.

This raises the question: what is the maximum that we can achieve. As mentioned, we need to have the latest version of Free Pascal and C++ compilers. The Free Pascal has bootstrapping and is independent from the Linux operating system libraries. On the other hand, the C++ environment on the Linux uses GCC and GLIBC, on which Ubuntu system strongly depends on. Having that in mind, one can conclude that it is impossible to have a new GCC/GLIBC set without having the whole system updated. If we want to make a highly professional competition we need to have them both on the latest stable version. So, in this scenario we will have to settle.

B. *Windows – (let's install Windows XP on the existing hardware)*

Although the Ministry of education and science decided to use Linux as the operating system the hardware offers the possibility to install other operating systems from the Windows Family. The most compatible one is Windows XP. The vendor (NComputing) has special drivers which modify the operating system and the terminals are actually remote terminal server sessions which connect to the host PC. This is one of the main disadvantages because Windows does not allow the same user to be logged in on multiple terminal sessions. That forced us to implement GINA alternatives for central authentication. Also it created the need for additional security measures since the modifications made from Ncomputing disable standard permissions protections which are enabled in Windows XP.

Other disadvantage that appeared was the need for activation of every terminal client with licence from Ncomputing. This was a manual process of entering several serial numbers and corresponding activation number with a slow process which was done on the Ncomputing support web site. This can be a problem for large scale deployments but the problem was resolved with use of imaging solution which cloned the host PC without the need of additional configuration.

For the central login system we used pGina [3] which provides a GINA replacement to standard windows logon with the possibility to use RADIUS. In this way we could generate a large number of users for which we could control their username/password combinations.

When the major problems where resolved, one additional issue appeared. An unexpected problem occurred with the programming environments since they generally use single directories where they put their temporary files, which in our case was a problem because 7 users share those resources and that caused strange compile errors. The solution was a trivial one, and required to use special installation procedures for CodeBlocks, FreePascal etc. which allow these temp files to be in the user temp directory instead of the system temp directory.

At the end, we managed to make this solution viable but in order to be applicable in every school there was a need to image the needed number of computers with this special windows image and after the competition was finished to restore the original Linux software set.

C. *Cloud – (let's use the cloud for the contestant machines)*

The solution that requires the least preparations in the schools is using remote desktop connections to contestant virtual machines that have everything the contestant needs installed. The main question here is whether we have the networking capabilities to support the whole competition.

For example, we could have 80 contestants. Given the requirement of 26.4 Kbps per user for a stable RDP session, in order every contestant to have a stable session, the minimum required bandwidth on the upload level is 2.5

Mbps, which scales to at least 4 Mbps for a smooth experience [4],[5]. Since the schools already have ADSL connection which usually is 12 Mbps download and 1 Mbps upload and the need for upload is big as much as for the download, the minimal option for a normal user experience is at least 4 ADSL aggregated as one [6]. Still, in peak times these requirements are higher. Other means of connecting the terminals to the virtual machines have greater constrains.

Other issue is the accessibility constraints required for an appropriate competition. We need our contestants to have only access to mendo.mk and nowhere else. So, we will need for the virtual machines not to be able to connect to any other location.

As other discussed scenarios, this solution is not flawless, too. If a single line from the suit fails, than a full reconnect has to be made, after which all of the contestants will wait for a fresh full screen. This can be carried out only if we are able to put through all the contestants at 100% usage. We can minimize the bandwidth needed by streaming images with lower quality, and with disabling some options like Windows ClearType.

On the other hand, the preparations needed at the sight of the event are minimal, which leads to the minimal need of local logistic.

The last but not least thing worth mentioning is that the hosts require certain implementation of the RDP. Windows has a native support for it, whereas on Linux it might be tricky to get it up and running using the old version of the OS, since the libraries might already be obsolete.

V. Limiting the Internet Access

No matter which solution we choose from the proposed, we still need to provide uninterrupted access via Internet to the competition server at mendo.mk. Since the schools have one central router on which we will not have access it is very difficult to limit access to some resources (a necessary requirement for quality competition).

The solution for the limited internet access is in the idea to create a small virtual appliance which will only allow Internet access to mendo.mk. Additionally, this appliance can provide the resources for the RADIUS authentication for the windows solution and also, in case of problems with the internet connection, can help the organisation team to fix them in a short period.

VI. Comparison of the Proposed Scenarios

After we analysed the three different solutions it was very difficult to choose the right one. Every solution has its weak points and having the right capacity for the Internet connection was the main point for the choice. Also, some solutions require more preparations on the technical level and over the years they can be difficult to maintain.

The cloud solution is the most complex one but on the other hand it's the most scalable since we can easily adapt to the number of contestants with deployment of additional virtual machines at the cost of needing more Internet bandwidth.

The Linux solution is the worst since in reality will not provide the needed working environment for all the programming languages which was enough reason to abandon its additional analysis and testing.

The windows solution has advantage because it can be based on local resources especially since we can put the virtual router authentication provider appliance on a standard PC and then we can deploy the needed working places without greater destabilisation in the existing infrastructure. But, the whole imaging and re-imaging on the Windows software and then the original Linux software will require better on site support and coordination which can be difficult to achieve in case there are limited human resources. Still, the windows solution will be easier to implement according to the current plan that the competitions should be held on different psychical locations and cities every year and in general the organisation team will only need to prepare this environment once. After it is prepared the only thing which will be needed the next time we want to use this infrastructure is to update the image with the latest programming environment (updating Codeblocks and FreePascal IDE).

VII. Conclusion

In this paper we have explained three different possibilities to organize the contest in informatics with the current hardware available in the Macedonian secondary schools. We hope that the ideas discussed here can provide valuable guidance for similar problems.

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