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Costs Efficiency in Deploying a Virtual Laboratory

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Abstract: *Implementing a virtual laboratory is a challenge launched by technologies developed to date. The purpose of implementing a virtual laboratory is to make available to students a variety of modern software without changes to existing hardware. In this paper we present a version made with low-cost implementation, conducted under a public-private partnership and we emphasize benefits all parties involved, but also possibilities for development of this concept in educational institutions.*
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Introduction

Virtualization is a technique that creates a virtual version of reality. In the software field, virtualization is about creating an instance of an application using hardware resources of the host system. Virtualized software can refer to any application, even on an operating system.

An operating system virtualization is the key to implementing a virtual laboratory, because each workstation can use a new operating system along with all the necessary applications without making any changes in the structure of existing hardware and software.

This could be achieved through local execution of virtual operating system, but this variant requires a direct dependence of the local hardware features. In this paper we intend to present a virtual laboratory available on any device, without changing the structure of hardware and software, even if they do not meet requirements of a modern system.

The experiment was made possible thanks to a partnership between the university and the private sector through resource sharing. Thus, the university has provided network infrastructure and location for the proper functioning of the server provided by a company.

Virtual Laboratory is managed by the company and used by both parties when requested. Due to used technologies the lab is accessible from anywhere in the world via the Internet. This provides increased mobility to all beneficiaries and they can access resources anywhere and anytime.

From the point of view of costs, they should be viewed from two perspectives, namely: the costs generated by university and the company costs. If we consider both perspectives it can be offered a global view on costs.

Cost is a very important aspect in the management of any organization, for that reason we want to present the costs generated by the experiment.

1. Cost Efficiency through Virtualization

In the acquisition of a computing system, the purchaser most often wants a "performance" that "needs to face" a long period of time as the acquisition process be not repeated very soon. This approach, in terms of costs, generate an increase in financial efforts required for acquisitions, but increasing the time until a new renewal plan is a reduction in cost per unit of time.

From our point of view, this approach may be flawed because in the first part of the product life-cycle, its performances are oversized, system resources being used at very low levels, which leads to an inefficient allocation of the costs.

Over time, software applications increasingly require more hardware resources, that is why towards the end of the normal duration of use, the system becomes overloaded and eventually replaced by a new acquisition.

In accounting, this depreciation is recorded in amortization. For IT equipment it is used the accelerated depreciation method precisely because these assets have a quick depreciation. From this point of view, accounting assigns higher costs in the first period of use and lower, towards the end of the period so as to allocate the entire amount of the purchases made.

We believe that this approach is not very effective because in the first period of use of the system, when high costs are allocated, while the level of resource utilization is the lowest. It is true that there is an offset in the second half of their life cycles, but inefficient hardware resource allocation remains a problem.

Replacement cost of equipment is another problem of inefficiency. Thus, at the end of life of a product, its value is very low, in many cases without the possibility of capitalization. Most purchasers, at the end of life of equipment are forced to quash old equipment without recovering anything and make a new purchase. The cycle repeats as described above.

What if a computer or any other equipment "antiquated" can be used long after the expiry of its life cycle?

The answer may be the dream of every IT purchaser. It will allow him at least two variants for cost effectiveness:

1. Allows to extend the life of existing equipment without making renewals, leading to a decrease in cost per unit of usage time
2. Allows realizing acquisitions at low cost, without having to invest in performance, in which case is solved the inefficient allocation of resources over the life of the product.

Both scenarios are in favour of cost efficiency. At a first glance it appears to be a cost savings that generate a decrease in quality. Computer users should raise a new question: Systems "underperforming" or "outdated" can meet the demands of modern software?

The answer is YES. Just as here comes the "magic" of virtualization. Through these technique systems less efficient can use the processing power of a single high-performance system thus solving two problems of costs described above: use a high level of hardware resources during the entire operation of the host system and increasing duration of use guest systems.

2. Hardware and Software Needs

Above we have presented some aspects of the cost efficiency through virtualization. Herein after we want to present a concrete implementation process with all the actual costs involved in this endeavour. In this experiment, besides cost efficiency by implementing virtualization solutions, we have tried other cost reductions so finally to get the most efficient model possible with the lowest cost and the maximum performance.

Implementing virtual laboratory implies, like any IT solution, a strict correlation between hardware and software applications used. Hardware used in the implementation is divided into two categories:

- Server system - supplied by the company;
- Networking equipment - provided by the university.

The server used to create virtual laboratory has a number of key features including:

- HP ProLiant chassis SE316M1;
- Processing Unit - two Intel Xeon L5630 2.13 GHz Quad Core with hyper-threading technology which together provide 16 cores;
- RAM - 48GB;
- Storage - 2 x 1TB HDD arranged in RAID.

The acquisition cost of the system was about 400 Euro, considering buying a refurbished system.

Choosing a refurbished system was made precisely in the context of cost reduction. A similar system at the time of acquisition, if it was new product could reach values of approximately 2000 Euro.

Even in the refurbished system case, the product has a 2 year warranty and all components have been reconditioned and tested. Hardware requirements for supporting software applications are fully satisfied, which is why we think it was a successful purchase.

Analysing computer market with the 400 euro could be made acquisitions such as this:
- 1 to 2 laptops or
- 2 to 3 desktops.

Any of the above has been done with limited hardware performance.

Network equipment used in implementation were provided by George Bacovia University in Bacau, all the infrastructure is already in place for many years, so no additional costs were incurred.

If there is a need for an acquisition of the network equipment, the cost of this varies depending on network topography, but these costs are insignificant.

On the user side, the virtual laboratory does not require any additional investment in hardware. Basically, the technology used for connecting to a virtual laboratory allows the use of any type of computer, and access can be achieved even with mobile devices such as smartphones or tablets. Because of this fact we add this as a new cost-saving implementation of laboratory basically increasing the lifespan of existing equipment is diminish the cost per unit of usage time.

The software component used to implementation has been chosen keeping the same direction mitigation costs. In this sense we had in mind an approach oriented to concept of open source software.

The host operating system for virtual lab is Linux Ubuntu 14.04.3. [1] we did this choice because an operating system based on Linux kernel is very stable, secure and free to use. Ubuntu distribution was chosen because of its popularity. The chosen solution is not exclusive and it can be easily replaced by any other operating system, even Windows.

Considering the fact that the host system is going to run multiple different operating systems, we preferred a solution based on Linux because it requires very few hardware resources, it can be installed without a GUI, and thus managing to allow operating systems virtualized more hardware resource.

Another aspect needed to implement is virtualization software. We chose to use the VirtualBox [2] primarily because it can be installed directly from the Ubuntu software repository without complications on the installation of additional software. Also, Ubuntu community provides generous support for installation, configuration and use of this application. There are other similar applications, one such example being VMWare. [3]

Another software component required is represented by the operating system and applications that will run on VMs. We chose open source operating systems based on different Linux distributions. The chosen solution is free, so do not generate license fees, but also offers a number of further advantages:
- Linux-based operating systems have pre-installed all the necessary applications for using a computer (utilities, office suite, Internet applications etc.);
- Linux-based operating systems do not require additional security applications (antivirus, Internet protection, etc.) which allows a more efficient use of hardware resources;
- Linux-based operating systems are well known for stability and security;
- Linux-based operating systems use hardware resource more efficiently.

We must say that VirtualBox allows installing any type of operating system that can run on virtual resources allocated. For example, in the experiment we installed three kinds of Windows operating systems:

- Windows XP;
- Windows 8.1;
- Windows 10.

We also tested in the same conditions operating systems like Android and Google Chromium. In this sense, we can confirm that virtual machine software can run any operating system.

When using a proprietary operating system, it should be noted that the operating system license costs and the additional applications add to the overall cost of implementation.

For example, considering the rates charged by Microsoft for Windows operating systems and Office applications, the cost can increase by several hundred Euros. To these must also add prices of antivirus applications and other commercial applications. These are multiplied with the number of VMs deployed, reaching cost-cutting effort to become ineffective.

3. Implementation of Virtual Lab

The first step of the implementation process was the commissioning of the server and installing the operating system. As stated above, we used Linux Ubuntu Server 14.04.3. System image can be downloaded for free from site www.ubuntu.com, where you can choose the desired version. Version 14.04 is the latest with long-term support and it was launched in April 2014 and is maintained by Canonical for 5 years.

After completing the installation of the OS, we installed VirtualBox application. A Linux distribution based on Debian, which includes Ubuntu Linux, installing applications from software repository is achieved by a simple command such as: sudo apt-get install virtualbox.

We installed a series of server applications including: opens server, apache, proftpd, webmin etc. The purpose of these applications is to facilitate access to the system. We note that the server must be able to be controlled remotely accessing its resources from anywhere in the world.

In VirtualBox application we created a virtual machine with the following characteristics:

- One processing core;
- 2048 MB RAM;
- Optical drive CD / DVD;
- 10GB HDD;
- 3D accelerated graphics adapter with 128MB RAM;
- Network adapter.

On this configuration we installed Ubuntu Linux 15.10 [4] operating system, the latest version at the time. This operating system comes with all necessary users' applications.

Hardware configuration specified above is sufficient for running the system and its applications in optimal conditions. On the same configuration we tested the Windows operating systems and we can say that behaved well.

After updating the operating system and its applications we have prepared virtual machine cloning. Before cloning it, we saved an instance which can help recover damaged systems. By cloning a virtual machine is provided a copy with the same hardware configuration and the same information stored on its hard drive. The process is fast and avoids the time and effort required to installing a new operating system.

Applying elementary arithmetic in hardware resource allocation we thought that the host system can handle 10 virtual machines simultaneously:

- A processing core of 16 available;

- 2 GB RAM per machine of 48 GB RAM;
- 10GB HDD available in 1,000 GB HDD.

In these conditions, running 10 virtual machines simultaneously, these resources will be allocated to hardware:

- 10 cores;
- 20 GB RAM;
- 100 GB HDD.

It should be noted that these parameters are maximal, and in reality the system dynamically allocates physical resources so that they can streamline the use of resources.

Host system, given that the 10 virtual machines simultaneously operate at full capacity, still has the necessary hardware resources for operation:

- 6 cores;
- 28 GB RAM;
- 900 GB HDD.

For a Linux operating system, the above resources are more than enough, which is why there are reserves for at least five virtual machines.

Each virtual machine has connectivity to the network through the host system. Basically host system shares the network connection with each virtual machine in part by offering the possibility to access their remote desktop type techniques. If the virtual machine network is connected to the Internet, it is possible to access virtual machines through the internet. Thus becomes mobile virtual lab.

Linux operating systems can be accessed remotely through various communication protocols, even though those offered by Windows operating systems. Thus, from any operating system (Windows, Linux, Android, Ios etc.) can be make a connection to the virtual machines. In this context, the virtual laboratory is available on any platform, anywhere in the world.

Conclusions

We believe that virtualization is a technology that can streamline costs in IT departments. We noticed that an "investment" of 10 400 euro can sustain computing systems, so an average of 40 euros per system. This cost can be reduced up to 25 per system if we consider the reserve of hardware resources available on the server configuration used.

We must say that running 10 operating systems on a single server achieved a reduction in energy costs. If a computer consumes several hundred watts on average, 10 computers will consume 10 times more than a server. Related to the number of hours of use of the 10 virtual machines can be record a significant saving of electricity.

Using virtual laboratory in education requires a specific maintenance. The variant using traditional computing systems, maintenance activities are great time consuming. Time is another important resource for the organization. This can be streamlined into a virtual laboratory.

Basically, if a virtual machine fails, it can be easily removed and replaced by a clone without reinstalling system or other remedial activities. If you want a change of hardware resources, a simple change in the configuration of virtual machines achieved this goal without physical changes in system architecture.

Upgrade the host system allows immediate development of all virtual machines. For example, if you want more storage space, but the host system is no longer available, it can be install a new storage device thus providing the necessary space upgrade.

The scalability of Linux operating systems allows more than upgrade the system. In case you want a virtual laboratory development can be introduce a new host system. It can be interconnected with first one and work together as a single system.

Technology provided by Ubuntu for such situations is called MAAS – Metal as a service. Through it many physical systems can work together as one. This technology enables scaling a virtual laboratory without technical limitations. Basically in such a cluster can be entered as many systems allowing scaling virtual machines laboratory.

In the context of public-private partnership in which we conducted this experiment has opened a new local market for online services – renting virtual machines. At a price of 5 euros per month per virtual machine investment can be recovered in less than 12 months.

To simplify access to virtual machines, remote desktop system can be implemented via a web browser. This would be much easier to access virtual machines, especially through mobile devices.

We think that this experiment is successful because it led to a substantial reduction in costs of upgrading a computer lab. Also, through the partnership between the university and the private sector can develop new services in the local market, services to support organizations interested in controlling costs related to information technology.

References

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