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*Make Harmony Between Technology and Nature, and Your Mind will Fly Free as a Bird*
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# VIRTUAL LABORATORY OF MICROPROCESSOR TECHNOLOGY APPLICATION

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***Abstract:*** *The purpose of this paper is to introduce new virtual laboratory of microprocessor technology application which has been designed at TBU Zlin and TU Brno. The paper reveals possibilities of current virtualization technologies and software systems designed for remote access to software applications that can bring not only basic office applications to end users but also highly specialized software tools bound to specific hardware.*
***Key words:*** *virtualization, microprocessor, application, server*

## 1. INTRODUCTION

Together with growing virtualization technologies portfolio (wide range of virtualization products of VMware company (http://www.vmware.com/products/, 2010), Oracle VM VirtualBox or Linux-based technologies such are Xen or KVM) and their decreasing cost (actually, some of them are for a free) a consolidation of various HW/SW resources is affordable not only for enterprise sector but also for small business, non-profit organizations or event for individuals.

Case study discussed in this paper deals with virtualization of complete microprocessor technology laboratory called "Virtual Laboratory of Microprocessor Technology Application" (shortly VLAM) (http://www.vlam.cz, 2010) at TBU Zlin and TU Brno. The basic preliminary principles used in this scenario have been already discussed in article called "Virtualization Technologies as an e-Learning Support in The Academic Environment" (Bliznak, 2007). This paper deals with description of final implementation as well as with approaches and tasks which haven't been discussed yet and various problems which had to be solved during the VLAM system's implementation.

## 2. STRUCTURE OF VLAM SYSTEM

VLAM system consists of several virtual machines (virtual workstations) hosted by underlying hypervisor which are accessed via web interface. The system is designer for:

- Delivery of SW development tools and HW microprocessor devices communicating via USB or TCP/IP protocol to remote users/students
- Secured remote access to various software development tools like IDEs, debuggers, monitoring tools, etc.
- Monitoring of developed embedded system by using an IP camera and an oscilloscope
- Possibility of remote control of developed HW devices, oscilloscopes, signal generators and other needed HW tools
- Scheduling of work time between registered users/students

For that purposes a virtualized network infrastructure has been defined and implemented. During the development process of the virtual infrastructure several different virtual hosts (also called "hypervisors") have been tested and two of them were chosen as suitable for required needs:

- VMware Server 2.0.2 and
- VMware Infrastructure 3 (also known as ESX server).

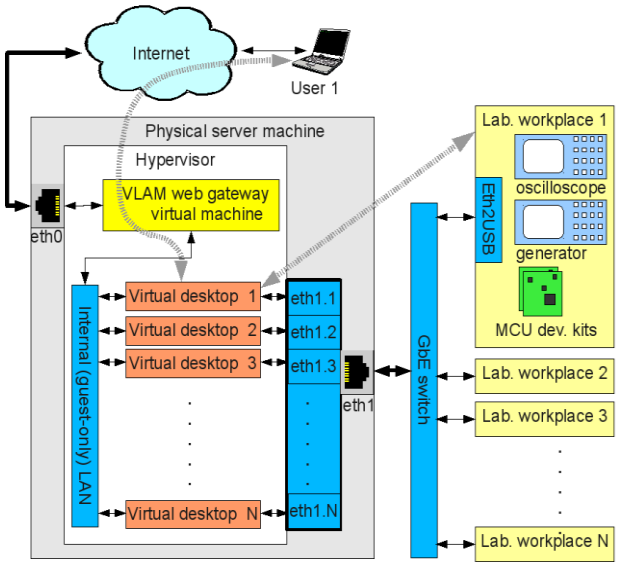


Fig. 1. Basic structure of VLAM system

The main reason for the choice is that this hypervisors currently provides the best performance for virtualization of MS Windows guests which were needed for running of crucial development tools.

From our point of view, essential differences between those two hypervisors are shown in following table:

| Hypervisor | Pros | Cons |
|---|---|---|
| VMware Server 2.0.2 | - available for free<br><br>- web-based administration console and console for access to virtual machine<br><br>- ability to connect real USB devices | - not compatible with all Linux kernels (patching of VMware Server is needed in some cases)<br><br>- underlying host OS is needed |
| VMware Infrastructure 3/ESX/ESXi/v Sphere | - stable and powerful administration console<br><br>- no underlying OS is needed (runs on bare metal)<br><br>- full commercial support | - expensive commercial product<br><br>- administration console available for MS Windows only<br><br>- real USB devices cannot be connected to virtual machines |

Tab. 1. Main differences between chosen VMware hypervisors

As can be seen from the table 1 there is no ideal solution for our needs. Since the virtual workstations have to access real USB devices the hypervisor must support this. Unfortunately the full featured commercial ESX server hypervisor doesn't offer this functionality (vSphere Basic System Administration , 2010) but this problem can be solved by usage of so called USB over IP (http://www.usb-over-network.com/, 2010). There are several different solutions available at the market today. Some of them are pure software-based, another ones includes specialized HW able to transfer USB traffic over network by using IP protocol.

On the other hand, free VMware Server suffers from certain incompatibility with some newer Linux kernels. The main advantage on free VMware Server is that real USB devices can be directly connected to the hypervisor and mapped to managed virtual machines.

For the final implementation of VLAM system VMware ESX Server hypervisor together with USB over IP technology have been used because of better support, stability and performance.

### 2.1 Security and reliability of the system

VLAM system is supposed to be accessed by number of users/students at the same time so it is crucial to ensure high level of security and reliability of the system.

Therefore, all data traffic between virtual machines and their users is controlled by software firewall running on VLAM web gateway which is responsible for routing of all communication and data streams. The firewall rules are automatically generated at the run-time in accordance to actual system state, configuration and number of logged users.

Also thanks to a physical separation of virtualized workstations from the host system any crash of published application or even of whole workstation OS won't affect other virtual machines. Moreover, damaged workstations can be easily recovered to its health initial state.

### 2.2 VLAM web gateway

Access to virtualized workstations is provided via web application called "VlamGateway". The VlamGateway website consists of two main sections:

- Public section allowing access to virtualized workstations
- Private administration section

The public section is intended to be used by ordinary users /students and provides access to published remote SW/HW development environment and monitoring system.

The private section allows system administrators to configure it, to grant various privileges to users, to manage published applications or desktops, etc.

### 2.3 Publishing of development tools

The main purpose of VlamGateway application is to provide access to remote virtual workstations with published development tools and monitoring system.

After successful login the user can use set o published applications and to watch handled microprocessor device by using IP camera as can be seen in figure 2.

Remote access to published applications is implemented in two different ways:

- Whole desktop of virtualized workstation can be accessed by using built-in java-based RDP client
- Single applications can be accessed by using 2X Application server

The access modes are configurable per-workstation only. The reason is that 2X Application server can run on MS Windows Server only in contrast to classical RDP desktop publishing which works also for MS Windows XP virtual guests.

Figure 2 shows the second mentioned approach, i.e. usage of 2X Application server. Application shortcuts placed under MCU board view can start published remote application on user's desktop.


Fig. 2. View to microprocessor device and applications list

Note that both approaches allow platform independent access to published applications because both java RDP client and 2X Application server clients can run on all main platforms such are MS Windows, Linux and OS X. Unfortunately, not all needed applications and development tools can be published by using 2X application server due to their licence restrictions forbidding usage from MS Terminal Server.

## 3. CONCLUSION

As can be seen from the paper nowadays virtualization technologies can be used for much more complex tasks then for consolidation of data servers. The work related to VLAM project revealed that also virtualization of workstations using highly specialized hardware and software tools is also possible. It also demonstrates that virtualization can be effectively used in academic environment as an e-learning support for delivering of hardware/software resources limited by their costs or reachability to students.

## 4. ACKNOWLEDGEMENTS

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