

# Usability of Virtual Machines in Laboratory Information Systems

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**Abstract** - Due to complexity of data acquisition and retrieval in laboratory information systems, special techniques are required to allow developers to have Biochemical analyzer at disposal all the time. Since most of the communication is done via RS-232, it

software in development through virtual machine. This paper considers such case and gives best practices acquired in development of our Laboratory information system.

**Keywords** - laboratory, information, system, simulator, virtual.

## I. INTRODUCTION

When developing information system such as one intended for use in Biochemical laboratories there is constant need for presence of apparatus from which the data would be gathered. Such biochemical analyzers are very robust and very expensive, so their dislocation is often out of the question. The development team is then forced to do lots of "on site" programming. The task becomes even more difficult when the machine is in constant exploitation.

The solution is to develop a simulator. Software that will respond to a query via RS-232 in manner identical to biochemical analyzer. Then, the data from the real analyzer would be collected and copied to simulators database. In such manner, programmers would have more than realistic situation when creating information system.

The simulator could then, be placed on dedicated server and connected to programmers machine via RS-232. After the programming is done, one should only disconnect the simulator and connect real analyzer to begin data retrieval.

Since such complex systems like Laboratory Information Systems (LIS) require big programming teams it is obvious that, more less every programmer would need one simulator connected. This task requires a lots of resources, and that is the place where Virtual machines are introduced.

## II. VIRTUALIZATION CONCEPT

A virtual machine was originally defined by Popek and Goldberg as "an efficient, isolated duplicate of a real

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machine". Current use includes virtual machines which have no direct correspondence to any real hardware [1].

Virtual machines are separated into two major categories, based on their use and degree of correspondence to any real machine. A **system virtual machine** provides a complete system platform which supports the execution of a complete operating system (OS). In contrast, a **process virtual machine** is designed to run a single program, which means that it supports a single process. An essential characteristic of a virtual machine is that the software running inside is limited to the resources and abstractions provided by the virtual machine - it cannot break out of its virtual world.

## III. ROADMAP

Before LIS integration into MIS, excessive hardware and software analysis should be done. Different vendors imply different communication protocols, as well as various interconnection methods [2]. Data acquisition from biochemical analyzers requires drivers for every brand, or even different driver for every model of the same brand.

Different data acquisition techniques may be applied. One of them, which is currently under development, involves creation of intermediate device which is installed between matrix printer and laboratory analyzer. This device gathers everything sent to printer, parse it and sends it through Ethernet to server.

Another, more strait through approach involves RS-232 communication and custom made communication protocols for every analyzer. Since analyzers require several commands to be send in order to respond with Patient data and measured values. To accomplish this, one has to do a lot's of trials on a biochemical analyzer. That is more than inconvenient, since programmers have different modus operandi in regards to laboratory staff.

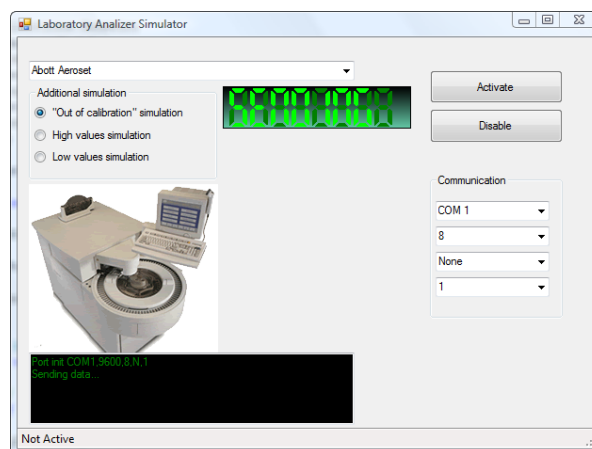


Fig. 1. Biochemical Analyzer Simulator

## IV. BIOCHEMICAL ANALYZER SIMULATOR

To improve development possibilities, biochemical analyzer simulator has to be created. This task requires prerecorded data to be stored into database and specific command sets to be created for every type of analyzer that will be simulated. Fig. 1. Shows user interface of simulator created for this purpose. User has available selection of Abott Axym, Abott Aeroset and Olympus AU-2700 analyzer at disposal. After selecting analyzer from drop down list, and setting COM port properties, the simulator will answer on every query received on COM port in a manner identical to real analyzer, with prerecorded data. The response will also be sent to COM port to fully emulate real exploitation environment.

## V. INTEGRATING SIMULATOR WITH VIRTUAL MACHINE

Full simulator installation is done after its installation inside virtual machine. Our environment required us to use VM Ware Workstation 6.5. This software allow user to fully customize virtual hardware. If direct communication of Host and Guest machines is required, bridge over physical COM port should be selected. On the other hand, if one requires communication between two virtual machines, named pipe should be formed to interconnect them. Figure 2. Shows the dialog to be used for virtual serial port setup.

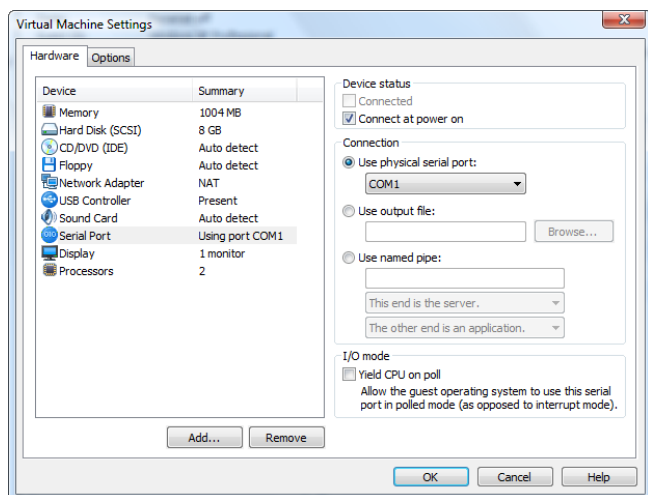


Fig. 2. Serial port setup

Using named pipes has its advantages. With slight adjustments in software it is possible to use one console to control several virtual machines over virtual COM ports.

VM Ware settings include two drop down lists which specify if the virtual machine includes Server or Client, and

what's on the other end, application or virtual machine. If Windows is used named pipe should look like [3]

```
\\. \pipe\<<NameOfThePipe>
```

And for linux:

```
/tmp/<NameOfThePipe>
```

Two different ways of accessing console exist, depending of Host operating system. In Linux (Fedora core) SOCAT utility is needed [4] for console to work. Installation process includes several commands :

**yum install socat** – will install socat utility  
**socat -d -d /tmp/<NameOfThePipe> PTY: -** will output what PTY device it creates, in this example /dev/pts/1. The only thing left is communication program like minicom which can be started with

**minicom -s**

It is slightly easier with windows where “Named pipes proxy” [5] utility has to be installed and configured, afterwards simple **telnet 127.0.0.1 <tepport>** will connect the host to virtual machine .

## VI. CONCLUSION

Virtual machines are very unique tool which can increase server utilization degree rapidly and thus reduce maintenance and development costs. There are several free solutions in market like Microsoft Virtual PC 2007, VM Ware Server and VM Ware Player. All of them show no lack of performance and are improved with every new release.

This paper showed one utilization scenario for virtual machines along with custom made biochemical analyzer simulator. The goal was to simplify development process, and to allow programmers to access analyzers in an simple, convenient manner

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## REFERENCES

- [1] Smith, Daniel E.; Nair, Ravi (2005). "The Architecture of Virtual Machines". *Computer* (IEEE Computer Society) **38** (5): 32–38. doi:10.1109/MC.2005.173
- [2] Vangelatos, Aristides; Sarivougioukas, John (2002). “Lessons Learned from the Introduction of a Laboratory Information System in a State Hospital of Athens, Greece”, Proceedings of the 36th Hawaii International Conference on System Sciences (HICSS’03): 0-7695-1874-5/03
- [3] Viewing serial output from a Vmware guest in linux and windows, Knol, A unit of knowledge, <http://knol.google.com>
- [4] Socat utility , <http://www.dest-unreach.org/socat/>
- [5] Named Pipes Proxy ,<http://shvechkov.tripod.com/nptp.html>