

Implementing Virtualization and Virtual Network Computing in NVLab, a web-based Computer Networks Laboratory

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1. ABSTRACT

ICT courses are accompanied with laboratory activities that help learners better understand the different concepts introduced in lectures and acquire practice on applying and troubleshooting them in close-to-real situations. Therefore, e-learning platforms offering such courses should have a web-based laboratory environment that can offer similar functions. Building such environment is the focus of our research where we use Virtualization and Virtual Network Computing technologies to setup NVLab, a web-based system designed to deliver *Computer Networking* laboratory activities.

2. INTRODUCTION

Laboratory activities are provided in parallel with lectures in ICT courses to help learners better understand the concepts they are being taught [1], and give them the chance to apply these concepts in close-to-real systems and troubleshoot any problems that may occur during this [2]. And to achieve this, enabling environment should be setup taking into consideration the special nature of ICT laboratories where each learner need to use multiple machines of many types and arrange them in different scenarios.

While on-campus laboratories have gone far in supporting these functions, web-based laboratories are evolving to become equal, or even better. In this regard, using virtualization and remote access technologies to build the new laboratory has emerged as an alternative to having the conventional laboratory arrangement supported with remote access capabilities. The new trend has been implemented in a number of courses and proved to be successful at serving large part of the required work. [3] [4]

Building on the previous work done and our own contribution in this field [8] and recognizing the need to offer learners an environment that provides tools for trying different scenarios rather than having a ready made network design, we used Virtualization (Xen) [5] and Virtual Network Computing (RealVNC) [6] to build a *Computer Networking* laboratory (NVLab) where learners can draw a network diagram, realize it on a remote server, and connect o this server to configure and test the work of the different devices included in the diagram.

3. SYSTEM DESCRIPTION

As shown in Fig. 1, NVLab incorporates a number of software tools that the remote learner will directly use

such as *Designer* and *virt-managere*, or will work in the background to support the various functions of the laboratory such as *Builder* and *VNC-server*.

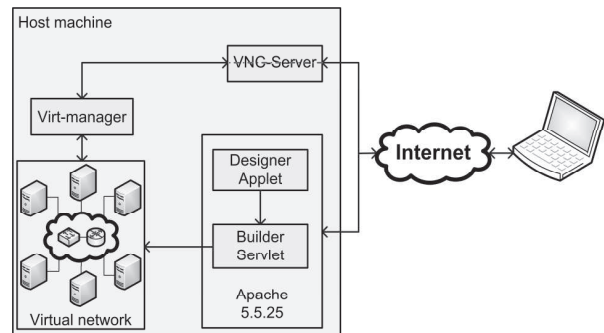


Fig.1 NVLab structure

Designer (Fig.2) is a GUI tool NVLab introduces to the learners for drawing a network diagram and sending an XML document representing this diagram to the server side. This tool is implemented as Java applet that, beside communication and printing capabilities, will ensure that the generated network diagram adheres to the standard designing rules required by Xen. For example, a connection can only be done between a device (PC or Router) and a switch.

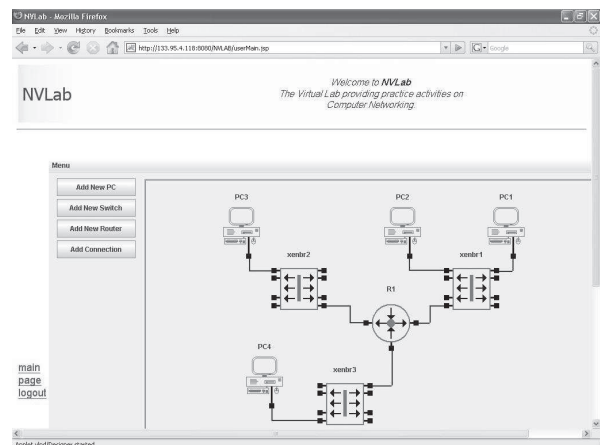


Fig.2 Designer applet

Builder is a Java Servlet that is responsible for receiving the network diagram from *Designer* applet and realizing it on the server side. *Builder* will use prototype VMs to create a Virtual Machine copy for every PC and Router included in the diagram and will create the

necessary configuration files defining resources assigned to each of them.

virt-manager [7] (Fig.3) is a GUI free tool that supports functions related to creating, deleting, and managing the virtual machines installed on the server. Learners will use this tool to start up the devices they have in their network diagrams and then configure and test their work.

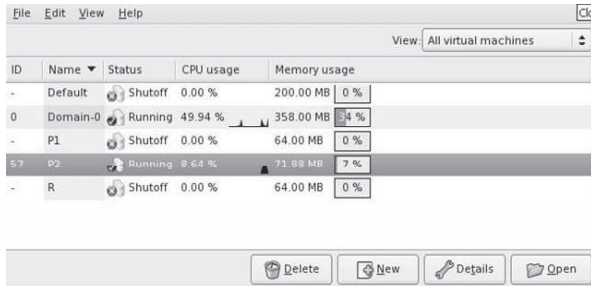


Fig.3 *virt-manager*

VNC-server is a software package bundled with some OS distributions (CentOS, for example) that enables remote access to centralized resources from ultra-thin or generic software. In NVLab, *VNC-server* accepts HTTP connections initiated over TCP port 5800+X where X is an integer representing the display number in Linux system assigned to the connecting user. This arrangement enables users to use any web browser to connect to the server via *VNC-server*. When they do so, users will get a Java applet containing the remote server's desktop (Fig.4) where they can perform the usual task as if they were using the server locally.

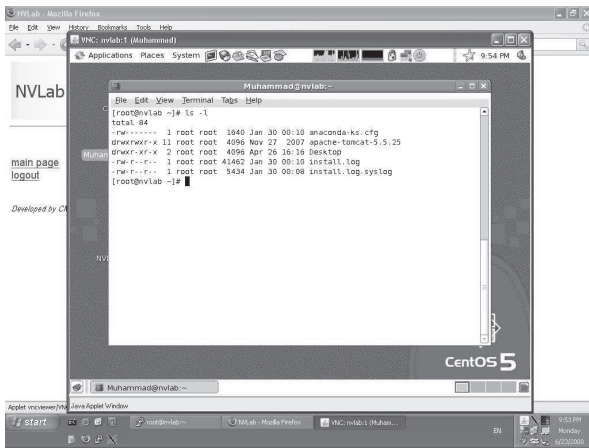


Fig.4 The remote server's desktop applet on the user side

NVLab is now hosted on a rack mounted server that has the following specifications:

- » Pentium D CPU running at 3.0GHz
- » 224GB of SCSI storage.
- » 1GB RAM

Apache Tomcat 5.5.25 is used as the web hosting container.

4. TASK FLOW IN NVLAB

To perform laboratory activity, learners connect to NVLab using their web browsers. Initially, they will use

Designer applet to draw the network diagram they will be working on, and to send this diagram's xml document to the server which will confirm the successful receive of the document. Then, the learner may select to create a network analogous to his/her diagram by invoking *Builder* Servlet from *Designer* menu, or simply redraw and send a new design again if any modifications are necessary.

Upon invoked, *Builder* will load the last xml file sent to the server side and will create VMs corresponding to the PCs and Routers included in it from prototype Virtual Machines (Switches are considered system devices and no alteration is now possible on their configuration). The time required to complete this task varies according to the number of devices the diagram comprises (4~5 minutes for each VM).

After giving enough time for *Builder* to complete its task, learners can connect to the server again via *VNC-server* through their web browsers and they will be able to start *virt-manager* which will provide them with consoles of all devices they included in their network diagram (Fig. 5). From these consoles, devices can be configured and tested whether they meet the lab activity targets or not.

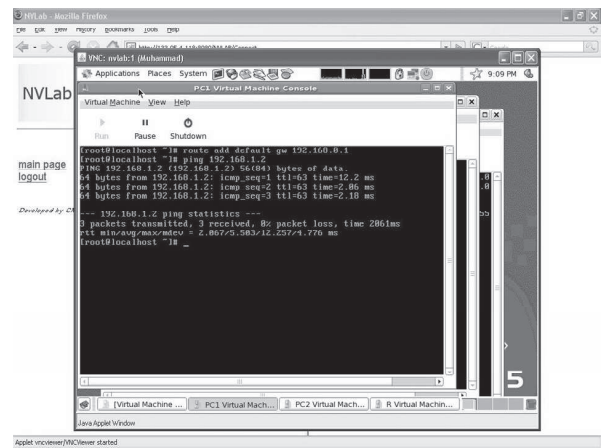


Fig. 5 VM Consoles as provided by *virt-manager*

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