Review on Virtual Laboratory in Network Security Education

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ABSTRACT
Virtual Laboratories has been accomplished as an economic support in educational institutions. Active participatory experiments are essential for computer network security education. Existing laboratory solutions usually require significant effort to build, configure, and maintain and often do not support reconfiguring ability, flexibility, and scalability. Using emerging technology such as cloud computing, Virtual laboratories are becoming popular in the educational as well as in business organizations [1]. The major constraints on the learning system are time and place. A cloud -based virtual laboratory education platform called V-Lab provides a contained experimental environment for hands-on experiments using virtualization technologies (such as Xen Cloud Platform) and Open Flow switches [4]. The system can be securely accessed through OpenVPN, and students can remotely control the virtual machines (VMs) and perform the experimental tasks. The V-Lab platform also offers an interactive Web GUI for resource management and a social site for knowledge sharing and contribution. The evaluation demonstrates that the platform and curriculum have produced excellent results and helped students understand and build up computer security knowledge to solve real-world problems.

Keywords- Virtual Laboratory, Xen Cloud platform, network security education, virtual machines, Interactive learning.

1. INTRODUCTION
Active participatory experiments are essential when educating network security specialists. However, it is tough for computer security education to keep pace with rapidly changing computer security issues to mimic real-world scenarios in a contained environment. This review paper reviewed an innovative cloud-based virtual laboratory platform called V-Lab that utilizes open-source virtualization technologies such as Xen and software defined networking (SDN) solutions such as Open Flow switches to construct a scalable, reconfigurable, and contained experimental environment for network security education. As time and place are major constraints in learning and education field, nowadays it becomes easy because of newly emerged technologies and rapid development in electronic and telecommunication and computer science field [3].

Virtual laboratories for studying network security are making importance for students, faculties and researchers. Traditional physical laboratories require purchasing high cost equipments such as routers, switches, firewalls, host computers, etc. Reconfiguration and maintenance of these physical laboratories are very difficult and time consuming. For networks security education we require highly flexible, scalable and reconfigurable and isolated laboratories. Therefore our traditional physical laboratories are not suitable for doing such experiments.

The design of V-Lab is based with the following improved features:

- A contained network security experimental environment providing dedicated virtual machines (VMs) and virtual networks to students;
- A reconfigurable networking environment with the flexibility to mimic various real-world computer networks;
- A collaborative laboratory environment with resource sharing and access control;
- A Web portal for user-centric resource management with knowledge sharing.

2. SYSTEM ARCHITECTURE
In this Section we will see the architecture of Virtual Lab.

2.1 Overview
The overview of the V-Lab system architecture is shown in Fig.1.Currently, the physical V-Lab system consists of a cluster of cloud servers with high-performance capabilities and virtualization support, an HP Open Flow switch, an array of storage area network (SAN) servers that provide VM storage and backup redundancy, and an uninterruptible power supply (UPS) system capable of 10 h of battery time for the entire system. The system allows up to 1000 VMs running various operating systems from Windows XP/7 to Ubuntu/Redhat.

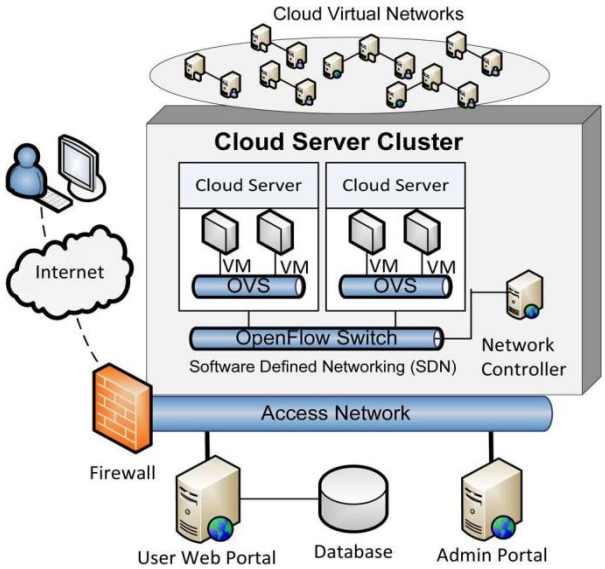

Fig.1 An Overview Of V-Lab System Architecture.

2.2 V-Lab Front-End User Web Portal

The front-end Web portal uses a real-time visual editor on the Web site to manage the virtual resources for experiments. Instructors can drag -n- drop multiple VM hosts into the canvas and configure them as various network devices. Once the con-figuration is complete, it can be submitted to the back-end virtual resource (VR) engine to allow enrolled students to perform experiments.

2.3 V-Lab Back End

The major components of the V-Lab back-end systems are established based on Xen Cloud Platform (XCP) and Open-Stack. The structure of XCP is as shown in fig. 2. Both XCP and OpenStack are open-source virtual computing platforms. The V-Lab platform allows students to work with special kernels or drivers of the VMs running in the cloud system. The system also uses open virtual switches (OVS) over generic routing encapsulation (GRE) through OpenFlow proto-cols with a network controller, e.g., a NOX/POX network controller to provide isolated virtual networking experiments. The back end also contains various internal services for administration and management purposes.

3. COMPUTER NETWORK SECURITY EDUCATION

As, Virtual Lab can be implemented with various domains, But it is mainly concerned with computer network security education. It can be summarized in three phases. The overview is given in Table 1.

3.1 Teaching I

It focuses on transferring basic networking and cryptography knowledge to students and preparing them for advanced experiments. During this phase, students learn to use V-Lab and to set up the experimental environment with a small number of VMs and networks that will serve as building blocks for the next phase.

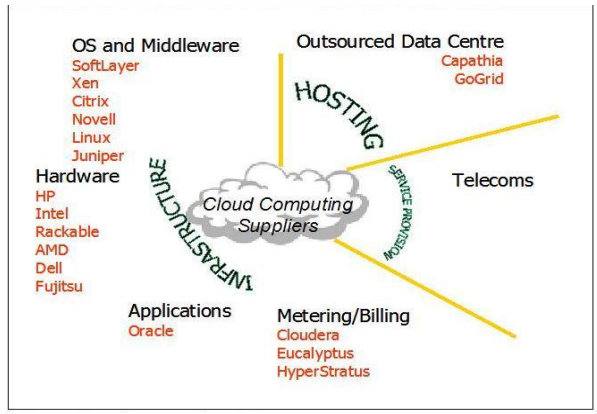

Fig.2 Xen Cloud Computing Structure

Phase	Goals	Sample Topics
Teaching I (Transfer Knowledge)	-Teaching and Transferring factual knowledge - Preparing students for experiments	-Network types and uses -Network layers and protocol hierarchies
Teaching II (Practice Knowledge)	-Demonstrating and practicing knowledge to solve real problems in collaborative fashion	-Firewall packet filtering using IP tables -Intrusion detection
Teaching III (Create Knowledge)	-Creating and researching knowledge while solving challenging projects	-Vulnerability scanning -Security testing

Table 1. Teaching Phases

3.2 Teaching II

It allows students to build upon the knowledge gained previously and apply it in more realistic and complex experiments. This phase requires students to work in groups and utilize various applications and techniques to build up a working solution for experimentation. The solution will be demonstrated and shared with other students during or after experiments.

3.3 Teaching III

It provides a list of advanced-topic projects that require students to research existing network security systems and build their own systems. During the evaluation process, students are split into groups to challenge others' systems while defending their own. This allows students to increase and consolidate their own knowledge and contribute to that of others.

3.4 Cyclic Positive Feedback Structure

Using V-Lab, the key points can be represented in cyclic structure.

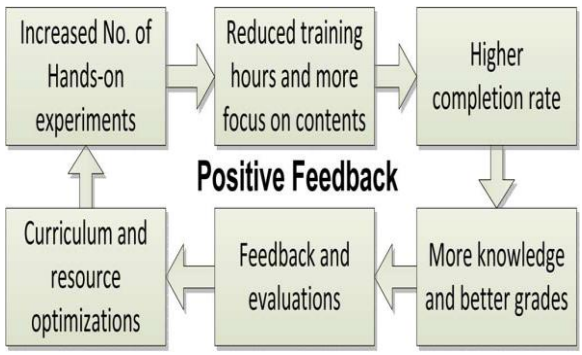

Fig. 3 Cyclic Feedback Structure

4. VIRTUAL LABORATORY IN INDIA

It is an Initiative of Ministry of Human Resource Development (MHRD) Under the National Mission on Education through ICT (Information and communication technology)[5]. Participating Institutes are as –

- IIT Delhi
- IIT Bombay
- IIT Kanpur
- IIT Kharagpur
- IIT Madras
- IIT Roorkee
- IIT Guwahati
- IIIT Hyderabad
- AMRITA University
- DAYALBAGH University
- NIT Karnataka
- COE Pune

The Project intends to cover physical sciences, chemical science and various branches of engineering like electronics and communications, computer science and engineering, electrical engineering, mechanical engineering, chemical engineering, biotechnology engineering and civil engineering [6].

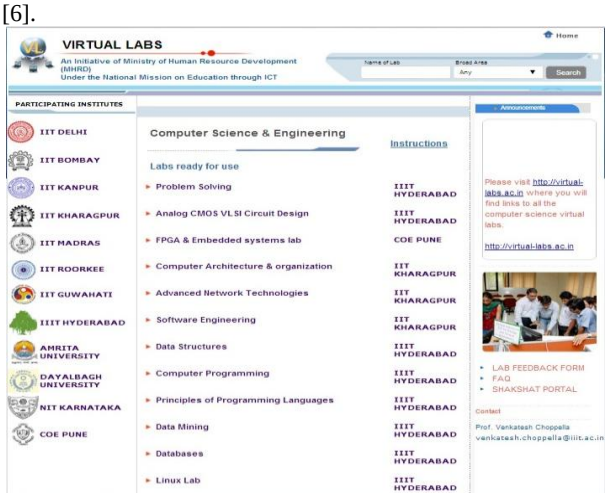

Fig.4 Virtual Lab In India

Fig.5 Virtual Wireless Lab By IIT Bombay

The project intends to develop a complete Learning Management System where the students can avail the various tools for learning, including additional web-resources, video-lectures, animated demonstrations and self-evaluation. There is also component wherein costly equipment and resources are shared, which are otherwise available to only a limited number of users due to constraints on time and distances. Figures 4 and 5 are showing the related information.

4.1 The Comparative study of Traditional Lab & Virtual Lab:

Educators made a comparison between the traditional lab & virtual lab [7]. Table 2 shows the comparison between them.

Sr. No	Characteristics of education in Traditional Lab	Characteristics of education in Virtual Lab
1.	Closed educational environment	Flexible & opened educational environments.
2.	In college lab the book and the teacher are the main sources of knowledge	In virtual lab , education depends on varied resources and multimedia.
3.	College lab provides the standardized official education	Virtual lab provides Continuous learning lifetime
4.	Teaching the whole class in large group.	Teaching the whole class through small groups or individuals.
5.	The individual differences are not considered in college lab.	The individual differences are considered in virtual lab.
6.	Verbal teaching methods	Varied teaching & learning methods.

Table 2. Difference Between Traditional Lab & Virtual Lab

5. CONCLUSIONS

A cloud-based virtual laboratory education platform provides a contained and private experiment environment for each student using the Cloud Plat-form and SDN approaches. The architecture can be extended to learn various subjects areas which are playing important roles in research areas. We can write following conclusions with future scope. V-Lab provides an interactive Web GUI for virtual resource management and a social site for knowledge sharing and contribution. The virtual resources created can be securely accessed .The system enable students to focus on content rather than the setting up of the environment. The system encourages a sharing and helps students gain more knowledge and better grades. In the future, the system can deploy high availability and redundancy features to provide a more reliable platform.

6. REFERENCES

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