

V-LAB REPORT FOR ACADEMIC 2012-2013

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07/31/2013

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1. Executive Summary

In Fall 2012 and Spring 2013 semesters, V-Lab system has served 279 unique students in 12 laboratories of 5 courses. Totally 511 virtual machines and VLANs are created to allow students perform experiments in a virtualized environment, and help instructors and teaching assistants evaluate and grade the experiment results.

At the beginning of Fall 2012, the development team of V-Lab incorporated multiple new technologies and improvements to the system.

- A new Web-GUI was built based on Drupal to integrate with ASU's LDAP authentication system, which allowed students to sign-in using their ASU credentials.
- The new Web-GUI integrates with a newly developed certificate management system to issue authenticated students ID and resource access certificates that are used for Single-Sign-On (SSO).
- The V-Lab system has been migrated from a IPTABLES-based port forwarding solution to OpenVPN-based system to provide scalability and secure communication. OpenVPN servers can be deployed at run-time in V-Lab system to increase the networking capability at run-time.
- The storage and backup system of V-Lab has been migrated from NFS-based file system to iSCSI-based block system to increase the storage capacity and availability.

During the Fall 2012 semester, V-Lab has encountered a few problems as follows.

- The OpenVPN-based solution only has preliminary scalability capability on the client side, which cannot be dynamically reconfigured at run-time. Also the client side solely depends on a random function that lacks a central control for load distribution.
- The virtual machines in V-Lab system are created using a pre-configured template and thus have same credentials when they first boot up. This may become a security issue when the virtual machine users forget to change the password.
- As a block storage system, iSCSI lacks the file system control of NFS. While NFS has full control on the file operations, iSCSI only grants read write privileges to accessing parties without any controls. This means the external party may damage the iSCSI data content without protection.

To address these issues and incorporate new cloud supported features, in Summer of 2013, we have made the following improvements for Fall:

- We migrate existing Xenserver-based cloud platform to OpenStack-based cloud Infrastructure-as-a-Service platform to meet the industry standard.

- The VPN-based remote access is one of drawback for remote access. To address this issue, we incorporate the web-based remote-desktop solution to bypass the VPN access issue.
- We increase the vlab storage (26TB) and computing capacity (10 cloud servers) using the fund provided by the engineering school.
- We implement the software defined networking (SDN) approaches to automate the network configuration procedure.
- We incorporate the user resource management panel for students. In this way, students can manage their own cloud resources.
- We incorporate the Hadoop support to make the distributed processing course projects become possible.

2. V-Lab Usage Statistics

This section presents the V-Lab usage statistics.

2.1. Supported Courses and Laboratories

The table below shows the laboratories and projects that have used V-Lab system in Fall 2012 and Spring 2013:

Course	Lab Name	Instructor	Course Name
468/598	Packet Filtering Setup	Tianyi Xing	Computer Network Security
468/598	Secure Web Service Setup	Tianyi Xing	Computer Network Security
468/598	Intrusion Detection and Penetration Testing using Snort, Syslog and Openvas	Tianyi Xing	Computer Network Security
468/598	OpenFlow Programmable Network Control	Tianyi Xing	Computer Network Security
545	Web Browser Vulnerability Lab	Stephen Yau	Software Security
545	A Web-Based Document Management System Lab	Stephen Yau	Software Security
465/598	Authentication-based Web Server Lab	Ahn Gail-Joon	Information Assurance
445/598	Web-based Application Development and State Management Lab	Yinong Chen	Distributed Software Development
445/598	Service-Oriented Software Development Lab	Yinong Chen	Distributed Software Development
445/598	XML and Related Technologies Lab	Yinong Chen	Distributed Software Development

2.2. Students Usage

Based on current curricula setup, the high volume of use of vlab is in Fall semester. Advanced Network Security (CSE548) is a course that heavily uses vlab; however due to my sabbatical, we do not have the class in Spring 2013. Thus, we made the major improvement of vlab in Spring 2013 and Summer 2013. This section presents the improvements and new features that have been developed and integrated with V-Lab system during Spring 2013 and Summer 2013 semesters.

The table below shows the numbers of students that have used V-Lab in Fall 2012 and Spring 2013.

Term	Course	Lab Name	Total Students	Grad students	Undergrad Students	% of Grad	% of Undergrad
F	468/598	Packet Filtering Setup	67	23	44	34%	66%
F	468/598	Secure Web Service Setup	67	23	44	34%	66%
F	468/598	Intrusion Detection and Penetration Testing using Snort, Syslog and Openvas	67	23	44	34%	66%
	468/598	OpenFlow Programmable Network Control	67	23	44	34%	66%
F	545	Web Browser Vulnerability Lab	74	23	51	31%	69%
F	545	A Web-Based Document Management System Lab	74	23	51	31%	69%
F	465/598	Authentication-based Web Server Lab	54	0	54	0%	100%
F	445/598	Web-based Application Development and State Management Lab	39	39	0	100%	0%
F	445/598	Service-Oriented Software Development Lab	39	39	0	100%	0%
F	445/598	XML and Related Technologies Lab	39	39	0	100%	0%
S	445/598	Service-Oriented Software Development Lab	45	45	0	100%	0%
S	445/598	Web and Related Technologies Lab	45	45	0	100%	0%
			677	345	332	48%	52%

3. Improvements and New Features

Based on current curricula setup, the high volume of use of vlab is in Fall semester. Advanced Network Security (CSE548) is another course that heavily use vlab; however due

to my sabbatical, we do not have the class in Spring 2013. Thus, we made the major improvement of vlab in Spring 2013 and Summer 2013. This section presents the improvements and new features that have been developed and integrated with V-Lab system during Spring 2013 and Summer 2013 semesters.

3. System Capacity and Estimation

3.1. Overview

The current V-Lab system has 8TB iSCSI storage for virtual machines. There are 4 XenServers with 24 CPUs and 64GB memory, and 4 XenServers with 16 CPUs and 32GB memory. Thus the total memory is 384GB, and the total numbers of CPUs is 160.

3.2. VM Templates

Each laboratory in V-Lab system consists of one or multiple virtual machines. The virtual machines are built based on pre-configured templates. Current system contains the following templates that are available to be created for laboratories:

- Ubuntu 10.04: 256MB Memory and 8GB Storage
- Windows XP: 512MB Memory and 8GB Storage
- Windows 2008 Server: 1GB Memory and 24GB Storage
- Windows 7: 1GB Memory and 24GB Storage

CPUs are not dedicated to VMs and thus need not to be included.

3.3. Estimated Capacity for Laboratory Hosting

Based on the current capacity of V-Lab, the approximate number of virtual laboratories that can be hosted in V-Lab is calculated as follows.

A typical Ubuntu-based laboratory assigns 3 VMs for each of 50 students:

Resource types	Resource per student	No. of students	Total Resources	No. of labs supported
Memory	256MB	50	12.8GB	30
Storage	8G	50	400GB	20

A typical Windows XP-based laboratory assigns 2 VM for each of 50 students:

Resource types	Resource per student	No. of students	Total Resources	No. of labs supported
Memory	512MB	50	25.6GB	15
Storage	8G	50	400GB	20

A typical Windows Server 2008-based laboratory assigns 1 VM for each of 50 students:

Resource types	Resource per student	No. of students	Total Resources	No. of labs supported
Memory	1GB	50	50GB	7
Storage	24G	50	1200GB	6

A typical Windows 7-based laboratory assigns 1 VM for each of 50 students:

Resource types	Resource per student	No. of students	Total Resources	No. of labs supported
Memory	1GB	50	50GB	7
Storage	24G	50	1200GB	6

The above calculations are based on the assumption of 100% resource usage. In the real world situations, V-Lab system has to retain 20% resources for redundancy or administration purpose, and thus the real number of laboratories that can be hosted by V-Lab system will be slightly less.

To sum up, the V-Lab system can support roughly 8 Ubuntu-based laboratories and 4 Windows-based laboratories at same, where each laboratory serves roughly 50 students.

4. Development and Enhancements of V-Lab In Spring and Summer 2013

The existing V-Lab Web-GUI has a self-developed JavaScript-based Web canvas that can be used for students to create and customize virtual resources for each experiment. The canvas was developed without native support for Web 2.0, and thus lacks the Ajax features for dynamic pulling and updating. It also does not work well with V-Lab's new Website, which is implemented in Drupal.

The new Web canvas is developed based on an open-source project jGraph, which comes with community support. The canvas can work closely with the backend Websites and databases to provide a user-friendlier Web-GUI to future V-Lab users. The development is in process. Based on students' feedback and our testing, the VPN-based remote access is one of drawback for remote access. To address this issue, we incorporate the web-based remote-desktop solution to bypass the VPN access issue. To further improve the user-management interfaces, we incorporate the user resource management panel for students. In this way, students can manage their own cloud resources. We also migrate existing Xenserver-based cloud platform to OpenStack-based cloud Infrastructure-as-a-Service platform to meet the industry standard. Based on the OpenStack framework, we implement the software defined

networking (SDN) approaches to automate the network configuration procedure. This feature can also assist us to incorporate computer networking and protocols related course projects.

To increase the system capacity, we increase the vlab storage (26TB) and computing capacity (10 cloud servers) using the fund provided by the engineering school. Moreover, we incorporated the Hadoop support to make the distributed processing course projects become possible.

References

[1] V-Lab: <http://vlab.asu.edu>