TRANSFORMING INFORMATION SYSTEMS AND COMPUTER SCIENCE EDUCATION WITH VIRTUALIZATION

Maurice E Dawson, Jr.
Jorja Wright
Jonathan Abramson
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Maurice Dawson¹, Jorja Wright², Jonathan Abramson³

¹Alabama A&M University (UNITED STATES)
²Florida Institute of Technology (UNITED STATES)
³Colorado Technical University (UNITED STATES)

Abstract

This paper will propose an innovative method to transform information systems (IS) and computer science education on a global scale. This method will introduce the use of virtualization and cloud computing combined with open source software (OSS) in higher education. This will allow for those studying IS and computer science to work independently on projects anywhere in the world from a baseline image that has been developed with information assurance (IA) controls. Additionally, this will allow professors and course developers to deploy their own customized virtual machines (VMs) to be used with the course. These VMs will host their own customized scripts, software applications, digital books, and more. This will help revolutionize online and on ground education in computing. For countries with limited resources, these VMs will allow for a more cost effective way to deploy training and perform collective research from any location given adequate internet connection. Provided will be a process for developing, deploying, managing, and retiring the VMs in the academic setting.

Keywords: technology education, virtual machines, Linux, hypervisors, computing, information systems, computer science.

1 CURRENT STATE OF IS AND COMPUTER SCIENCE EDUCATION

In the age of technology, secondary education computer science (CS) courses are quickly disintegrating from the curriculum. In 2005, basic CS courses were reduced by 17 percent [1]. In addition to this, one-third of advanced placement (AP) CS courses were removed from the teaching curriculum [1]. Unfortunately, only a handful of American high schools are certified to teach AP CS courses; therefore only a handful of American students were eligible to take the AP exam [1].

High School AP Examinee Statistics

![Figure 1. High School AP Examinee Statistic [2].](image)

The projected job outlook for IS and CS is 30 percent in a ten year span from 2004-2014 [2]. STEM occupations on a whole will increase by approximately 22 percent [2]. The current job projections for computer specialist occupations are expected to exceed average growth rate for other technology related fields [2]. Unfortunately, the decrease in IS and CS majors may lead to many open job positions in computer technology.
1.1 Government Accreditations for Cyber Security

Cyber security has become an essential career track within many organizations to include the U.S. government. The National Security Agency (NSA) and Department of Homeland Security (DHS) has developed a rigorous criterion to become certified as a Center for Academic Excellence (CAE) in Information Assurance Education [3]. Institutions such as Southern Oregon University have undergone the research process to understand the requirements to meet this new designation [4]. With this accreditation is the requirements to pursue IA research and have projects are associated with IA. Taking documents from organizations such as the National Institute for Standards and Technology (NIST) and the Department of Defense (DoD) baseline IA requirements can be applied to virtual machines (VMs) to teach how to develop compliant builds [5].

2 VIRTUALIZATION

Virtualization in computing is the act of creating something virtual. With virtualization professors have the ability to apply government related. Additionally, this allows for the creation of baseline IA hardened OS images for classes [6]. For example, a forensics course would have an OS created with all the network mapping, file searching, disk image analyzer, and etc. preloaded. This would allow an institution to have a hardened image ready for every class to ensure consistency, and that the students have all required tools needed which would ease the process for program accreditation [6]. Below is a figure of how the environment could be resembled from a system architectural view.

![Figure 2. VM Architecture.](image)

2.1 Open Source Software

Open Source Software (OSS) is software in which coders have access to the source code [5]. A few of the criteria programs must meet in order to be considered OSS include:

- The software can be freely redistributed.
- Source code is easily accessible and Software can be modified and new works can be derived.
- The software must remain true to the author's original source code.
- There is no discrimination of software to any persons or groups.
- Software may be used in any discipline, i.e. business or science.
- The original license distribution applies to all new parties that redistribute the software.
- The license should not be specific to the software.
- The license should not restrict other software.
- The license should be neutral to all technology and/or interface [7].
A few popular OSS Linux-based deployments are Ubuntu, Edubuntu, and BackTrack. Ubuntu is a replacement for traditional operating system software; Edubuntu is educationally based and focuses on grades K-12; finally, BackTrack is targeted towards college/university students majoring in IS or CS technology fields [8].

2.2 Hypervisors

When constructing the VM environment it is important to think about the overall architecture which includes the hypervisor [9]. There are two distinct types of hypervisors which are Type 1 and Type 2. The Type 1 hypervisor runs directly on the system’s hardware to control the hardware to include managing the guest OS. An example of this would be XenServer or VMware ESXi. The Type 2 hypervisor runs within the OS environment with the hypervisor layer as the second application software layer. The guest OSs run on the third layer above the hardware which is displayed in the figure below.

2.3 VMBuild Process

The build process used consisted of gathering all baseline requirements and capturing them in a file that hardened the OS according to the baseline requirement. Additionally, these requirements are captured so they can be applied later if needed. During this same process all course needed were captured and all applied to the VM as well. This stage we identified as the starting state. Once everything was applied and fully tested the VM moved to the deployable state. The deployable state is the state where the VM can be accessed by faculty, students, and other researchers. As requirements were updated or new common vulnerabilities and exposures (CVEs) were released so was the VM.
3 CONCLUSION

The current state of IS and CS majors in American universities is quite daunting. In fact, exposure to IS and CS leads many high school students to pursue these majors in college. The projected job outlook is promising in that in the next ten years, over 50 percent of new jobs will be in the computing and mathematics arena. With the increase in technology comes an increase in the need for cyber security. Various federal agencies, NSA and DHS are developing a standard in order to be accredited in Information Assurance Education. With virtualization, institutions can affordably create new innovative IA degrees according to the NSA CAE, teach complex cyber security, and perform groundbreaking research. OSS and its various versions may replace traditional computing, increase the use of technology within education while simultaneously reducing costs. Hypervisors aid in virtualization by controlling the hardware that manages the guests OS. Lastly, the build process employed aids in the creation of the VMs to support IA and other Science, Technology, Engineering, and Mathematics (STEM) fields.

REFERENCES


