5. (a) Proposal Title and Abstract

Proposal Title

Development of Portable Lab Modules on Cloud Computing

Abstract

Cloud computing is a highly scalable model for delivering information technology resources and applications, on demand, as a service, to end users throughout the network. In recent years, cloud computing has been adopted rapidly and widely in industry. Notable cloud services include Amazon Elastic Compute Cloud (EC2) and Google App Engine, among others. There is a fast growing demand for Information Technology (IT) professionals with cloud computing skills. However, the demand is not being fulfilled, partially due to the inability of educational institutions to keep up with technological advancements, as well as a lack of hands-on educational material. Currently, there is no course on cloud computing in our program. Instead of inserting new courses into the already crowded curriculum, we are proposing the development of six lab modules, which can be integrated in multiple courses to teach basic cloud computing concepts and skills early and often. The labs will run on virtual machines and can be easily ported between different courses. They will not only focus on cloud computing but also be pertinent to the objectives of the corresponding courses. About 96 students will be impacted in two existing courses: ICTN 2732 and ICTN 4700/01. Three lab modules will be used in each course as supplemental projects. Surveys and peer reviews will be conducted for assessment.
5. (b) Proposal Outline

5. (b1) Purpose/Objective

The purpose of this project is to introduce basic cloud computing concepts to Information and Computer Technology (ICT) students early and often. Six lab modules on cloud computing will be developed. The labs will be performed using virtual machines and incorporated into two existing courses. The labs will be designed as supplemental modules that adhere to the course objectives. To meet the learning outcomes of this project, the students are expected to: 1) comprehend the fundamental concepts of cloud computing; 2) identify the building blocks of cloud computing systems; 3) understand the basic operation of open source cloud infrastructures; and 4) recognize commonly used, commercial cloud computing services and applications. We believe this approach will serve our students well because 1) it provides students with multiple opportunities to learn cloud computing; 2) it does not require major changes to our curriculum and 3) it can be deployed and adjusted quickly.

5. (b2) Project Description (Approach/Method/Procedure)

The tentative titles of the lab modules are as follows: 1) Open Source Cloud I: Container-based Cloud; 2) Open Source Cloud II: Xen Cloud Platform; 3) Open Source Cloud III: Virtual Computing Lab; 4) Cloud Management using Red Hat Enterprise Virtualization (RHEV); 5) Exploring Amazon Elastic Compute Cloud; and 6) Google Cloud Connect. A lab manual, including an answer sheet, will be developed for each lab module. Custom virtual cloud environments will be created. A typical virtual cloud environment will consist of one or more virtual machines, on which the lab exercises are performed. Some lab modules will be accompanied with demonstration videos.
The project development will follow a four-step procedure. In the first step, the outcomes and tasks of each lab are identified. For example, an outcome can be defined as so: “After this lab is completed, the students will understand the process for setting up a private cloud system Virtual Computing Lab”. In the second step, the lab manual, the answer sheet, the virtual cloud environment, and supporting material will be developed. In the third step, the newly created labs will be tested and deployed. In the fourth step, the project will be evaluated and adapted.

We have extensive experiences in designing virtual labs and environments. Most of the newly created labs in this project will be hosted by a centralized cloud infrastructure on our fifteen high-performance servers, which were received through an equipment grant from Hewlett-Packard. This ECU teaching grant, if funded, will allow us to use these servers to extend the cloud infrastructure and to host the newly created virtual cloud environments for the lab exercises. Some labs can also be deployed in a decentralized manner, in which students run the virtual labs on their personal computers.

5. (b3) Need and Impact

Our program prepares students for careers in computer networking, information technology, information security, and technical management. “Learning by doing” is the core of my teaching philosophy. In the recent years, cloud computing has made transformative changes in IT services in industry, government and education. A quick search at online job sites such as monster.com, or dice.com, will demonstrate that there is a great demand for information technology professionals with cloud computing skills. It is unlikely that every student will become a cloud computing professional after graduation, but it is almost certain that she/he will work in a more and more virtualized environment that requires basic cloud computing skills. Students will also need a basic understanding of cloud concepts before they can take some
advanced IT courses. However, currently there are few educational resources in this area. We have been considering creating instructional materials on cloud computing to fill the gap. Instead of making major curriculum revisions or inserting new courses into our already crowded curriculum, we plan to develop portable lab modules which can be reused in multiple courses as supplemental projects. Our intention is to introduce basic cloud computing concepts to a large group of students early and often.

The lab modules will have long lasting impact on at least two existing courses I teach, as shown in the table below. Approximately 96 students will have the opportunity to acquire cloud computing skills during the first year of the project. Some fellow faculty members have expressed interest in using selected modules in their courses as well.

<table>
<thead>
<tr>
<th>Course</th>
<th>Percentage Impacted</th>
<th>Level</th>
<th>Size</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICTN 2732 Scripting for Information Technology</td>
<td>50 %</td>
<td>Sophomore</td>
<td>48</td>
<td>Spring</td>
</tr>
<tr>
<td>ICTN 4700/01 Virtualization Technologies</td>
<td>50 %</td>
<td>Senior</td>
<td>48</td>
<td>Summer or Spring</td>
</tr>
</tbody>
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5. (b4) Schedule of Activities and their Proposed Deadlines for Summer Session 1

**May 15 - May 21:** Define the outcomes and tasks of the lab modules.

**May 22 - June 22:** Develop six lab modules including manuals and virtual environments.

**Summer 2015:** Test hands-on labs in ICTN 4700/1; conduct two peer reviews.

**Spring 2016:** Use new hands-on exercises in two courses; conduct student surveys to determine the usability and make adjustments accordingly.

**Rationale for why the proposal requires summer stipend:** It is very time-consuming to create and test the proposed lab modules. The grant proposer teaches full load of courses in the fall/spring semesters. The summer is the best time to develop the labs.
5. (b5) Evaluation Plan

**Peer Evaluation:** The peer reviews will be conducted before and after the spring 2016 semester. The new lab modules will be reviewed by at least two professors in the Information and Computer Technology Program. They both have extensive teaching and research experiences. They will assess whether the goals and outcomes of the project are viable and whether the goals of lab modules are aligned with the objectives of the courses.

**Student Evaluation:** To measure if the learning outcomes are met, the lab reports submitted by students will be used. In addition, a survey will be conducted anonymously and voluntarily to assess the outcomes, the degree of interest, the degree of satisfaction with the project, the usability and the availability of the virtual cloud environments. The surveys will contain true/false (TF), multiple choice (MC), multiple answer (MA) and opinion scale (OS) questions.

Here are some sample questions for the pre-class survey:

1. Which of the following statements is a valid description of cloud computing? (MC)
2. Which of the following hypervisors can be used to build a private cloud? (MC)
3. Which of the following cloud infrastructure managers support live migration? (MA)
4. Amazon EC2 provides platform as a service (PaaS). (TF)

Some questions from the pre-class survey will be reused in the post-class survey to measure students’ progress in meeting learning outcomes. Here are additional sample questions for the post-class survey to assess other effects of the project:

1. The supplemental projects facilitated my understanding of cloud computing. (OS)
2. The supplemental projects helped increase my interest in cloud computing. (OS)
3. The virtual cloud environments were easy to use. (OS)
4. On average, how much time did you spend on each supplemental project? (MC)