Transition to Amazon AWS from a Traditional Cluster-Based Information Technology Classroom

Vamsi Gondi
vkgondi@bsu.edu

David Hua
dhua@bsu.edu

Biju Raja Bajracharya
bajracharya@bsu.edu

CICS, CCIM, Ball State University
Muncie IN

Abstract

In the age of COVID-19, traditional teaching techniques are under scrutiny. Most concepts and labs in the area of information technology are intended to be taught face-to-face in labs using clusters and networking infrastructure. Simulation software's such as ucertify, pearson online, etc.., are good alternative, but are not always a viable solution. Simulation software is used primarily to understand, remember, and apply the concepts rather than analyze evaluate and create the content. Due to unforeseen conditions during March 2020, educational institutions were required to shut down. In the middle of the semester, instructors had to determine how to complete the labs and final projects which are crucial to accomplishing the intended learning outcomes of their courses. A chosen alternative was to use Amazon AWS as a cloud platform to host the labs and projects. It was initially a challenge as students had not had the opportunity to learn how to work with AWS in advance. Training sessions were provided to help them understand how to deploy and connect virtual servers in AWS to build a virtual private cloud. Prior to the pandemic, students developed and deployed their labs and projects on a departmental cluster which was on-premise at the university. With AWS, it was challenging to design an architecture to host 19 services offered as a part of the project requirements for an organization network. This paper presents the scope of this project; the intended outcomes of the project, how students were able to implement the project requirements in the AWS environment; the intended learning outcomes; and the results of student surveys to assess the learning outcome of using AWS and traditional cluster.

Keywords: Learning outcomes, Assessment, Project based learning, Blooms Taxonomy, Amazon AWS, Cloud Computing Cluster, Servers and services.

1. SCOPE OF THE COURSE AND FINAL PROJECT

CT 321 is an advanced server operating system course. The course is structured to learn 19 different Linux based services and concepts: Linux installation; modifying the Linux kernel; RAID configuration; logical volume management (LVM); network interface bonding; deployment and configuration of Dynamic Host Configuration Protocol (DHCP), Domain Name System (DNS), Secure Shell (SSH), Network Time Protocol (NTP) and Server Message Block (SMB) services, Apache server deployment and website

configuration, OTRS server, Openfire server, MySQL, OpenVPN server, Nagios, Lightweight Directory Access Protocol (LDAP), and Fail2ban.

Students were to complete the lecture and labs for the first 12 weeks of the course. The final three weeks were dedicated to completing final project. Prior to the COVID-19 pandemic, the labs and final project were completed on the department's cloud cluster. During their prerequisite courses, students acquired the skills needed for the configuring and managing the cluster and network infrastructures.

Project Scope and Scenario

The students are divided into groups of three, and asked to work as a consulting firm. This consulting firm needed to design and deploy an open source data center solution for a fictitious corporation, CompTech, LLC. The project description stated that the company has slowly been growing in size since 2004. Starting with a mere 20 users and 2 IT staff, CompTech, LLC had grown to now serving 170+ users and 5 full-time IT staff. The company currently has a band-aided setup where the network core device is handling processes that ought to be managed by real servers. The company also had a storage cluster that recently failed and needs to be replaced with a newer more stable system. CompTech has been relying on mismatched and varying operating platforms for their needs and recently acquired new hardware to rebuild the data-center.

CompTech desires a new infrastructure and has enlisted outside assistance in accomplishing this task. The final result, to be effective, must be:

- Secure
- Quick to load
- Stable/reliable
- Administratively simplistic
- Well documented
- Cost effective

CompTech LLC, has 3 HP DL360 1u servers, 1 DL380 2u or 1 DL385 1u storage array already racked and ready for implementation. All servers are currently wired to network equipment as well as a Raritan KVM system to allow ease of administrative tasks. The servers are also connected to a monitored and switched power distribution system.

2. TASKS AND DELIVERABLES

The project is setup with multiple tasks:

Task 1 - Initial vendor tasks:

- Introduction of team members and consulting company name
- Collecting project information
- Identifying project implementation time-line

Task 2: Vendor testing stage tasks:

- Determining system capabilities
- Gathering configuration information
- Building test environments for services needed
- Integrating test environments to mimic real-world production environments
- Documenting all test system configurations, IP addressing, administrative information, and more.

Task 3: Implementation phase tasks:

- Implementing the proposed system on provided hardware as a proof of concept
- Testing the implementation of the systems
- Documenting all user names, passwords, configurations, settings, miscellaneous administrative information, etc.
- Preparing a formal report to provide CompTech at the end of implementation

Task 4: Vendor proposal and presentation tasks:

- Conducting a formal presentation for CompTech, LLC in professional dress. The presentation should include primary deliverables; focus on added value the project creates for the business while not being overly technical
- Providing CompTech, LLC with the proposal and findings from the test systems
- Answering questions from CompTech in regards to planned implementation

Task 5: Testing:

- CompTech, LLC should be able to use all systems to 100% of their proposed solution.

Deliverables:

Students were supposed to submit multiple deliverables during the course of the project.

- A written report about their group's chosen server platform
- Project management plan
- Specifications and requirements document
- Implementation document with screenshots and instructions on how to install, use and maintaining the servers and services
- Providing an oral presentation with slides

3. AWS TRANSITIONING

Due to COVID-19, the university was closed midway through the semester. The department cluster is isolated from the university's production infrastructure. Since the degree curriculum

includes courses on wired networking, wireless networking, and cybersecurity which need to be delivered in our labs to prevent any disruptions on the university's production infrastructure. Due to this, VPN connectivity for the students to work on their projects in the department cluster is not available.

The closing of the campus forced faculty to find alternative platforms that were publicly accessible that would allow students to complete their labs and final project remotely. Many of the faculty were already experienced with the Amazon AWS (Amazon, 2020) cloud platform for research purposes. At the university level, faculty and administrators worked together to establish an institutional account with AWS Educate to provide students with no cost access to AWS.

To prepare students to work in the Amazon platform, students participated in workshops on the basics of AWS, how to access AWS and EC2 cloud. They were trained on how to create instances, connect to them remotely, transfer files and data, connect multiple instances, security configurations for port accessing, and managing the virtual private clouds. These workshops were conducted in parallel with regular online classes to ensure the course stayed on schedule.

For completing the project, students were asked to create and use EC2 instances instead of the department's physical cluster and assume the project is moved to AWS rather than in-house servers.

Major Issues:

Students faced several challenges due to AWS architecture when trying to deploy DNS servers, DHCP servers, security group configurations, and VPN to external clients. Most of the issues were resolved by students using the resources provided by AWS and researching online how to configure the services in AWS.

4. PROJECT OUTCOMES

This version of the project has been assigned for three semesters. Most of the students complete the project by deploying the server VMs and services on the departmental cluster. But the project goal is to design a system architecture which is resilient. The servers and services need to complement each other such as remote logging, RAID configuration on storage servers and server back-ups to the storage servers. This has proven to be difficult due to limited physical resources in the cluster.

The unplanned transition to AWS placed a steep learning curve on the students. Despite this requirement, four of the six student teams successfully accomplished all the tasks. The remaining two teams nearly completed the necessary tasks.

This project engaged students in learning activities that increased their subject knowledge expertise. The activities were designed in accordance with Bloom's Taxonomy to promote the understanding, application, analysis, evaluating and creating (Blooms Taxonomy, 2020).

The unplanned transition to AWS resulted in additional programmatic and student learning benefits. The outcomes have provided support for reducing programmatic dependencies on premise hardware. The low to no cost educational platforms offered by Amazon AWS and Microsoft Azure provide students with the opportunity to learn and create in an environment that more closely aligns with industry best practices. In turn, the enhanced student learning outcomes supports the need for on-going curriculum development that will keep the degree program relevant.

5. STUDENT SURVEY

After the completion of the course, a survey was given to participating students. The survey was to determine the relative benefits between using AWS or the department cluster. Of interest was whether students perceived either learning platform to be more effective accomplishing the intended student learning outcomes. Most of the students had little to no experience working with AWS. We also conducted this survey with the students who took this course in previous semesters to gage their outcome of the project.

Students who worked on the project in cluster and AWS felt the project was very complex and lot of time was invested to complete the project. Additionally, students who worked on AWS expressed even more complexity when integrating the project with AWS. On the other hand, students who completed the project in AWS felt they gained very good knowledge on AWS, how it works, and how to apply projects with AWS in the future. Also, most of the students expressed interest in working with both cluster-based and AWS combined, as they feel cluster can help on physical infrastructure management and AWS with cloud based.

Most of the students expressed interest in working with both traditional cluster and cloud-

based environments. They also think the knowledge of cloud-based environments such as AWS will significantly boost their employability.

6. CONCLUSIONS

COVID-19 created an opportunity to explore another teaching tool that can be used in the classroom. Transitioning was very challenging, especially when we are dealing with the students. As a faculty, we had to prepare ourselves for every difficult scenario. This was one of those occasion we went beyond the calling. The experience of using AWS as a teaching and learning platform has encouraged faculty to reconsider their course design and deliver models. The availability of data storage and disaster recovery, using AWS and S3 storage containers allows faculty to create more robust assignments that more accurately reflect the work environments they will encounter upon entering their professional careers. We feel AWS with traditional cluster knowledge will boost student's capabilities as this project demonstrates the same.

9. REFERENCES

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Survey Questionnaire

1. Have you ever have experience in working in cloud environment (rate 1 to 5, 1 for low and 5 for high)
2. Which cloud environment do you have experience with
   a. Amazon AWS b. Microsoft azure c. IBM bluemix d.others (please specify) e.none
3. At what level of experience do you have working with Amazon AWS (rate 1 to 5, 1 for low and 5 for high) before the starting of the project
4. Did you worked on the CT321 project using AWS
   a. Yes b. No
5. Did you accomplished all the tasks mentioned in the project description
   a. Yes b. No c. Some what (AWS)
   b. Yes b. No c.some what (Non AWS)
6. What level of difficulty did you face while working on the project environment (rate 1 to 5, 1 for low and 5 for 5)
   a. AWS
   b. Non AWS
7. At what level of experience do you have working with Amazon AWS (rate 1 to 5, 1 for low and 5 for high) after completion of the project
8. Have you ever completed any project with traditional cluster at BSU
   a. Yes b. No
9. Which one do you think more effective in completing the project
   a. Traditional b. Cloud based (AWS)
10. Do you think you gained experience on working AWS (rate 1 to 5, 1 for low and 5 for high)
11. How do you rate this project completing in cluster(rate 1 to 5, 1 for low and 5 for high)
12. How do you rate this project completing in AWS (rate 1 to 5, 1 for low and 5 for high)
13. In future which one do you prefer
    a. AWS b. Cluster at BSU c. none of them d. Other (Please specify)
14. Do you think learning AWS will boast your career when you enter job market
    a. Yes b. No
15. Rate this project complexity (rate 1 to 5, 1 for low and 5 for high)