



CLOUD-CLASSROOM: SELECTING THE RIGHT PLATFORM FOR VIRTUAL OPERATING SYSTEMS LABS

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ABSTRACT

The adoption of cloud computing in higher education has transformed the delivery of practical courses, enabling remote access to computing resources without the need for costly physical laboratories. This study focuses on selecting an appropriate cloud computing platform for building a virtual online laboratory to support the Operating Systems (OS) course. The research compares various cloud service providers and virtualization tools based on scalability, performance, cost, ease of integration, and support for OS-level experiments. A multi-criteria decision-making methodology is employed to evaluate leading cloud platforms, including Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP), as well as open-source solutions such as OpenStack. Experimental results reveal that a hybrid cloud setup, combining commercial scalability with open-source flexibility, offers the most suitable environment for OS labs. The proposed solution enables seamless deployment of virtual machines (VMs), containerized environments, and kernel-level experiments, enhancing both accessibility and learning outcomes.

I. INTRODUCTION

Operating Systems courses traditionally require access to dedicated hardware and laboratory environments where students can practice kernel programming, process management, memory allocation, and file system operations. However, maintaining physical laboratories is costly, resource-intensive, and inaccessible to remote learners. Cloud computing offers a paradigm shift, allowing students to access virtualized lab environments through the internet, thereby reducing infrastructure costs and providing flexibility in learning. The selection of the right cloud platform is

crucial for ensuring performance, reliability, and affordability in such virtual laboratories. This paper presents a structured approach to evaluating cloud platforms for supporting OS courses, emphasizing hands-on accessibility, real-time scalability, and pedagogical integration.

II. LITERATURE SURVEY

Cloud computing in education has been extensively studied in recent years. Buyya et al. [1] established cloud computing as a utility model suitable for resource allocation in academic environments. Sultan [2] highlighted the educational potential of cloud-based systems, particularly for e-

learning and laboratory virtualization. Marinos and Briscoe [3] discussed cloud computing architectures, comparing public and private clouds in academic use. OpenStack and other open-source cloud platforms have also gained attention for their flexibility in academic deployments [4]. Furthermore, Alabbadi [5] surveyed cloud computing trends in higher education, emphasizing cost-effectiveness and accessibility. More recently, Almseidin and Poovammal [6] evaluated the performance of different cloud providers for virtual lab environments, concluding that commercial providers offer superior scalability while open-source solutions ensure customization. These studies provide a foundation for the current research, which specifically focuses on the Operating Systems laboratory and the unique requirements of kernel-level experimentation.

III. SYSTEM ANALYSIS

EXISTING SYSTEM

The traditional approach to conducting Operating Systems (OS) laboratory sessions relies heavily on physical computer laboratories equipped with dedicated hardware and pre-installed software environments. Students are required to attend in-person sessions to perform kernel-level experiments, process scheduling tasks, memory allocation exercises, and file system simulations. While this setup ensures direct access to computing resources, it also introduces challenges in terms of cost, scalability, and accessibility.

DISADVANTAGES:

1. High Infrastructure and Maintenance Cost – Physical labs demand continuous investment in hardware, software licenses, and maintenance, which is financially burdensome for institutions.
2. Limited Accessibility and Flexibility – Students must be physically present in the lab, restricting remote learning opportunities and limiting access outside scheduled hours.
3. Scalability Constraints – Physical resources are finite; during peak usage, not all students can access machines simultaneously, leading to resource bottlenecks.

PROPOSED SYSTEM

The proposed solution is a cloud-based virtual laboratory that delivers Operating Systems experiments through cloud computing platforms such as AWS, Azure, GCP, or OpenStack. Instead of relying on physical hardware, students access virtualized environments via the internet, enabling them to perform kernel modifications, process management, and system-level programming tasks from anywhere. The system integrates scalability, remote accessibility, and flexible resource allocation, making it a modern alternative to traditional labs.

ADVANTAGES:

1. Cost Efficiency and Easy Maintenance – Cloud platforms reduce the need for constant

hardware upgrades and simplify software management through centralized deployment.

2. Remote Accessibility and Flexibility – Students can access the OS lab anytime and anywhere, supporting distance learning and self-paced study.
3. High Scalability and Resource Optimization – Cloud-based labs can scale on demand, allowing multiple students to run experiments simultaneously without resource limitations.

IV. PROPOSED METHODOLOGY

The methodology for selecting the cloud platform involves four stages. First, the requirements for an OS virtual laboratory were identified, including support for VM provisioning, kernel-level access, multi-user scalability, and fault isolation. Second, candidate cloud platforms were shortlisted, including AWS, Azure, GCP, and OpenStack. Third, evaluation metrics were defined, covering cost efficiency, scalability, system performance, user accessibility, and administrative overhead. Finally, a multi-criteria decision-making model (MCDM), incorporating Analytical Hierarchy Process (AHP), was applied to assign weights and rank platforms. Both quantitative (latency, uptime, VM boot time) and qualitative (ease of integration, pedagogical suitability) measures were included in the assessment.

V. EXPERIMENTAL SETUP

The experimental setup involved deploying identical OS lab environments across different cloud platforms. Ubuntu Linux was chosen as the primary operating system, with configurations supporting kernel compilation, process scheduling experiments, and memory management simulations. AWS EC2, Azure Virtual Machines, GCP Compute Engine, and OpenStack were configured with comparable VM specifications (2 vCPUs, 4 GB RAM, 40 GB storage). Performance metrics such as VM boot time, latency, CPU utilization, and storage I/O throughput were recorded under varying workloads. Additionally, usability tests were conducted with 40 undergraduate students enrolled in the OS course, who were asked to perform standard lab exercises such as implementing system calls and scheduling algorithms. Surveys were used to capture student satisfaction and perceived ease of use.

VI. RESULTS AND DISCUSSION

The experimental evaluation revealed significant differences among cloud platforms. AWS and Azure demonstrated superior scalability and system reliability, with average VM boot times of less than 40 seconds. GCP offered cost advantages but exhibited slightly higher latency under peak workloads. OpenStack, while less scalable, provided greater flexibility for customization, particularly in granting students deeper kernel-level access not always permitted in commercial platforms. From the student perspective, AWS and

Azure scored highest in usability due to intuitive interfaces, while OpenStack was rated highly by advanced students who preferred more control. Cost analysis showed that open-source solutions significantly reduced long-term expenses but required higher administrative expertise. Overall, the hybrid approach—leveraging AWS for large-scale scalability and OpenStack for flexible kernel experimentation—proved to be the most effective strategy.

VII. CONCLUSION

This research demonstrates that cloud-based platforms can effectively replace traditional OS laboratories by providing scalable, flexible, and accessible environments. The comparative analysis revealed that while commercial cloud services such as AWS and Azure excel in performance and scalability, open-source platforms such as OpenStack offer unique advantages in customization and cost efficiency. The proposed hybrid solution ensures that students gain both accessibility and deeper experimental control. By adopting cloud-based OS laboratories, universities can expand access to practical computing education, reduce infrastructure costs, and adapt to evolving educational models such as remote and blended learning. Future research may explore container-based virtualization and serverless computing models to further optimize cloud classrooms for operating systems education.

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