

# Using Hybrid Cloud and Mobile Platforms to Enhance Online Education

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## Abstract

Technology is a major part of the knowledge imparted in class, so instructors need to make use of advance techniques in teaching in order for students to be exposed to the opportunities offered by new technologies. This research is based on vMoodle, a virtual-machine-based online education system that addresses the gap in our current instructional technology by seamlessly integrating existing online learning and virtual machine software. Furthermore, vMoodle Mobile is an extension of vMoodle that allows users to access this learning environment through mobile devices. Although vMoodle already makes some efficient choices regarding storage usage, its storage demand may increase up to the point where the private cloud might need some external support. In addition, vMoodle Mobile could take advantage of the processing power found in the new smart mobile devices in order to further enhance the user experience making the vMoodle system truly versatile.

## 1. Introduction

vMoodle [1] is a novel online educational system that supports seamless integration of virtual machine (VM) based education in a convenient online learning environment such as Moodle. Online learning software (e.g., Moodle [2] and Blackboard [3]) is widely used by teachers and students to conveniently create, distribute, and consume course materials such as slides, homework, and quizzes. Meanwhile, virtual machines (e.g., VMware [4], VirtualBox [5]) are increasingly used for creating self-contained and portable educational modules that can be transparently distributed and deployed anywhere. vMoodle addresses the gap between virtual machines and online education software in our current instructional technology. It proposes a new software system that can seamlessly integrate our existing online learning and virtual machine software and can support our students and faculty to use them in a coherent online environment.

vMoodle Mobile further allows instructors and students to use vMoodle through mobile devices such as smartphones and tablets. vMoodle Mobile possesses a device friendly interface so the device screen, storage, and other features can be used efficiently [6]. The prototype was developed in Android since it is open-source and widely used. The previous system implementation of vMoodle includes a remote desktop protocol (RDP) connection to the VM, but this strategy is unsuitable for mobile devices, especially smart phones. The reason for this problem is that smart phones have a small screen and the interaction with the full desktop transmitted by the RDP connection is awkward and slow. Therefore a command line interface is more mobile user-friendly. In order to achieve this a third party Android [7] applica-

tion called ConnectBot [8] was used to connect to the virtual machines via an SSH (Secure Shell) connection. Additionally, it was established by running experiments that using ConnectBot did not compromise or slow down user interactions in comparison with the rest of the App's transitions.

## 2. Load Balancing Across Hybrid Cloud

In order to make VMs more accessible to users and make the system able to support more VMs, load balancing between the private cluster and public cloud is necessary. The current vMoodle system lacks VM management and load balancing. While it has only been used in the private cluster, it has the possibility of using public clouds [9] like Amazon's EC2 [10].

Given the future amount of users of vMoodle, there will be a need to prevent individual servers that contain more popular VMs from overloading and be-

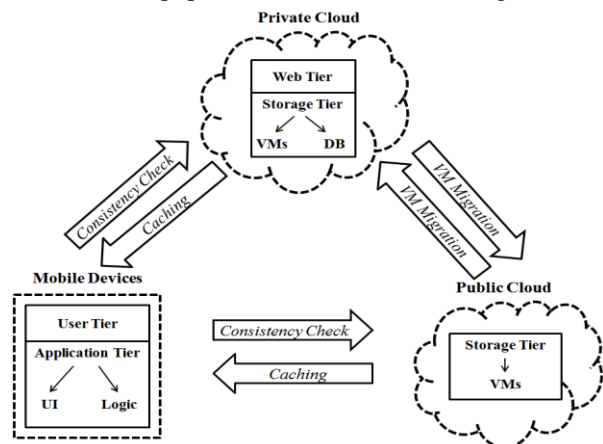


Figure 1 - System Architecture Diagram

come unavailable. In addition, the main attraction of the vMoodle system is that VMs can be accessed anytime from anywhere, so users should not be disturbed when the server in which their VM is running becomes increasingly used. Therefore vMoodle needs to support live-migration of VMs between private cluster and public cloud transparently to the active users (Fig. 1).

Furthermore, since the private cluster has a limited amount of resources and sometimes schools don't have the budget to buy more equipment it would be a good strategy to shift the load to public clouds. Since we are only charged by the resources we use, we could use the public cloud for VMs that are rarely used and don't utilize many resources. By expanding the amount of resources available for this educational system, we would be able to improve its availability and scalability properties.

### 3. Caching on Mobile Devices

In order to improve the user's experience and the overall system's responsiveness a smart caching algorithm in the vMoodle's mobile application is required. Mobile devices are being increasingly used and have become an essential item for everybody in our society. vMoodle Mobile, further extends vMoodle by taking advantage of this popularity and making vMoodle more attractive for students to use. This mobile application relies heavily on the processing power of the cloud behind it which could potentially disappoint users who expect fast response of mobile Apps. In order to avoid trading off application responsiveness for computational power a solution must be found so a balance between both is achieved (Fig 1). Having the computational power of the cloud is important because virtual machines could use large amount of resources, but the load can be distributed on the local resources of the mobile device. By caching VM related information on the mobile device, access and interaction with the VM can be achieved much faster.

Moreover, using smart algorithms to cache only the most relevant information or most accessed pieces of data can accomplish efficient use of the storage. In addition, a limit must be enforced on the amount of data cached since the mobile device is likely running other kinds of application and the storage is shared between them. Once the I/O processing is not the bottleneck of the communication between the device and the cloud we could also make effective use of the processing power of the mobile device.

### 4. Conclusions and Future Work

The solutions to the problems proposed in this paper are new and will take substantial research efforts

in order to accomplish their goal. Designing and implementing a system to allow vMoodle to do load balancing inside the private cluster while considering off-loading resources to the public clouds is a complicated matter. Similarly, finding an efficient way to cache vMoodle on mobile devices, while achieving seamless interaction with the user, is very challenging.

The addition of load balancing between private and public clouds and the caching algorithms on the mobile application of vMoodle have been devised in order to make this educational system more effective and enhance the educational experience for students while exploiting emerging cloud, mobile and social networks technologies. Education has been moving rather slowly in this field, so this solution will not only help the users of vMoodle, but also set an example for other universities to use the never ending opportunities that new technologies offer for educational purposes.

### 5. References

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