Developing multimedia distance learning services using mobile cloud computing

Aleksandar Karadimce, Danco Davcev, Ustijana Rechkoska Shikoska

University for information science and technology "St. Paul the Apostle"

Ohrid, R. Macedonia

aleksandar.karadimce@uist.edu.mk, dancho.davchev@uist.edu.mk, ustijanars@uist.edu.mk

Abstract*:*

The integration of the mobile devices with mobile cloud computing is achieved by diversity of services that are supported by wireless technologies. The main contribution of this paper is the integration of the mobile devices within the mobile cloud computing environment for multimedia distance learning. By using the hardware resources from High performance clustering centers and variety of services offered by the mobile cloud computing technology our approach improves the Quality of Learning (QoL). This way learners are provided with all necessary laboratory resources and scaffolding during the learning process, which makes an efficient distance learning expressed by Quality of Experience (QoE) estimation which is directly related to the QoL.

Keywords - *mobile cloud computing; multimedia distance learning; HPC; virtual servers; QoE; virtual lab.*

I. Introduction

The combination of mobile devices and wireless communication offers huge potential for distance learning, assuming how acquainted most of the young students are with these mobile technologies. As we move these applications from the desktop to more universal and increasingly powerful mobile devices, we could simply move existing tools to new emerging platforms [1]. Using mobile devices in the multimedia distance learning systems provides the learner with scaffolding outside the classroom, by allowing them to store and record media that reflects its experience. The existing distance learning process that uses the mobile devices have disadvantages that needs to be solved: small capacity of storage, limited computation power and enormous energy consumption [2]. In order to enhance the power of mobile devices we integrated them within the cloud computing environment that offers massive storage capacity and processing power [4], [7].

Integration of mobile and wireless technologies offers new perspectives in distance learning environments that take place anywhere anytime [1]. Most research show that cloud computing will be the basic environment and platform in which mobile learning is supported and promoted by Software as a Service (SaaS) [6]. Multimedia learning typically includes different kind of multimedia resources such as audio, video, images, text etc., since they provide an efficient learning environment that helps learners to be more interactive and interested in collaboration. The mobile devices are likely to integrate your everyday functionalities and provide a networked multimedia device that is always with you. These capabilities will transform everyday activities by providing the students ability to capture details about the time, location and increase the quality in the process of learning.

Related to this proposal is one of the existing solutions asking for downloading a specific mobile application which has to be installed on the mobile device. Then through the GPRS/WiFi connectivity they can

access the content over the cloud and the user can select among various available topics the one he needs [6]. Today because of the existence of numerous mobile devices that use custom mobile operating systems, it is not feasible to develop so many different mobile applications. Similar to [8] in our paper we use the web browser that is integral part of mobile devices to be used for accessing the distance learning course using the mobile service. Learning resources can be represented as web pages that are accessible using communication services and mobile cloud computing. The benefit of using cloud computing and SaaS concept is widely recognized for talents training in the Universities [3]. The related paper [4] presents implementation of interactive learning through mobile devices combined with the new technology of cloud computing where live lectures from the instructor webcam streamed to the cloud. In this way the students interact with the lecturer. With this paper we go beyond and provide students with virtual lab where they can have hands-on practice using the benefit of cloud computing. The main contribution of this paper is improvement of the quality of learning in the process of distance learning using the hardware resources from high performance clustering centers and variety of services offered by the mobile cloud computing technology.

This paper is organized as follows. Section II describes the layers of service oriented computing framework. The Section III presents our proposed service oriented mobile cloud computing (MCC) architecture. Section IV describes our Experimental Distance Learning (DL) course and in Section V presents the results from comparison of Quality of Experience (QoE) evaluation. Finally Section VI concludes the paper.

II. Layers of service oriented framework

We propose layered service oriented computer framework (see Figure 1) where all of the services are based upon the ability to request service from different group of layers. Similar framework could be found in [11]. However, we propose an adapted version suitable for application in education. Infrastructure layer is the first group dependent upon provisioning the other services and integrates network equipment, multimedia repository and other hardware resources. Platform layer provides a group of Development, Application and Multimedia adaptation services where users are able to build development environment and application deployment platform. These two layers are similar as in [5]. In addition we propose business abstraction of the application software provided by learning, evaluation and collaborating. Benefit of interactivity is key issue in the distance learning system, which is why we propose increased collaboration with students and continuous evaluation. The top layer, service access layer, similar to [6], offers GUI, API service and user interface which allows integration and aggregation of all the services such as IaaS, PaaS and SaaS by classifying them from these different layers into the mobile cloud computing architecture.

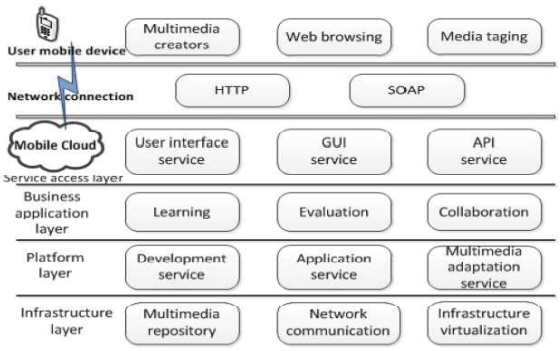

Figure 1. Layers of service oriented computer framework.

The multimedia mobile distance learning provides an intuitive and collaborative environment where users can experience the advantages of flexibility, portability and scalability.

III. Service oriented mobile cloud computing (MCC) architecture

Integration of mobile devices during the multimedia distance learning is done in order to improve and increase the collaboration, availability and scalability for the learners. Scalability as one of the most important feature of the cloud computing [4] is provided by integration of the mobile devices with the HPC (High performance computing) centers. This gives mobile devices increased computational capabilities allowing these devices virtually to reach the level of high powerful computers [7]. Using the existing mobile services users of mobile devices can easy send their requests to be processed within the mobile cloud computing environment. The proposed service oriented mobile cloud computing architecture provides delivery of augmented multimedia learning course to the users of mobile devices (see Figure 2).

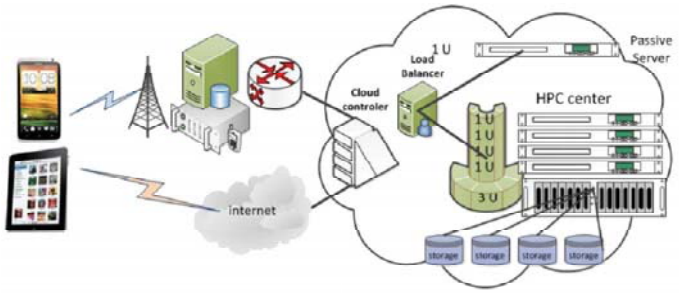

Figure 2. Service oriented mobile cloud computing architecture.

In [12] a generic mobile learning framework was developed. Mobile devices' native functions and existing Web 2.0 applications are used to provide a mobile learning content. However, in our approach we use virtual servers on the HPC to provide our mobile learning content. The mobile cloud computing platform that we propose uses the benefits form HPC centers, where multiple virtual servers are created, and can be easy accessed by learners that have mobile devices. Owners of different kind of mobile devices (iPad, iPhone, HTC etc.) using the diversity of access networks can connect to internet and telecommunication providers (using WiFi, WiMAX, UMTS, GPRS, HSDPA and EDGE). These networks provide diversity of services for browsing (WAP, HTTP), data services (file transfer, email download), and streaming media (music, video, events). The intention is to provide a set of mobile services that will allow mobile devices to interface with mobile cloud. The access from mobile provider to the HPC center is done by using mobile gateway internet connection and tablets have ability to access the mobile cloud using internet connection.

HPC center is consisted of 84 computational blade servers with 2 Six core L5640 CPUs and 24 GB RAM. The 6 management servers have also 2 Six core L5640 CPUs and 24 GB RAM, four of which act as storage servers and are connected in a failover configuration to a Serial Attached Small Computer System Interface (SCSI) storage with 60x600GB Dual channel Serial Attached SCSI (SAS) disks. Particularly the overall theoretic performance of the HPC cluster is 9 TFlops, and achieved peak LINPACK performance is 7.776 TFlops, and provides possibility for deployment of any needed library or software pack. Using these services will enable development of augmented multimedia learning course that will be user oriented and will provide flexible teaching laboratory. The HPC controller manages the authorized access to the HPC Center, and it is directly connected to Load Balancer, which determines which server is active passive or active server.

The advantage of proposed architecture is that it offers new services to mobile users, as exceptional benefit from using the HPC center within the mobile cloud environment. Real multimedia objects, such as pictures, videos or audio files recorded during the classroom learning have increased the motivation for learning to the students. They have also included their notes and assignments to the mobile learning process which augmented the mobile learning course and help them to improve the quality of learning.

IV. Experimental Distance Learning (DL) courses

During the spring semester 2012 our students attended at distance learning course from Norwich University from Vermont, USA in area of cyber-attacks and defending computer networks. Distance learning course was divided into two parts. Firstly students got **theoretical** *knowledge* (*A*) for computer networks security and the tools that they will use later for attacking and defending computer networks. During the **practical** *tutorials* (*B*) they were familiarized with the working environment, applications and a tool that offers Back Track operating system, as one of the best OS intended for cyber-attacks.

*A. **Theoretical** knowledge for cyber-attack and defending computer networks*

During the theoretical lectures there was interactive communication between the two Universities using the WebEx application that offers broad range of tools for chat, talk, virtual whiteboard and etc. We have conducted analysis, with Norwich University, that for this type of distance learning is best to use WebEx, because offers broad range of Web conferencing services, including a Meeting Center, Event Center, Training Center, Support Center, video conferencing, and content sharing [9]. Other benefit of this application benefit is that no software download is required for use and will run on any Laptop, touchpad or mobile devices such as iPad, iPhone, HTC sensation or other mobile smartphones. The theoretical knowledge for computer networks security was thought, by sharing Power point and using the WebEx annotation tools for teaching the students, see Figure 3.

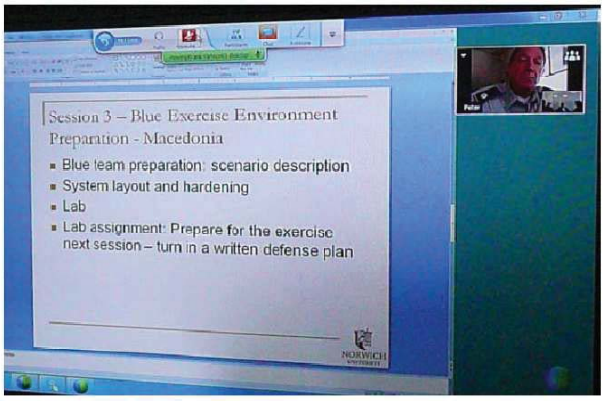

Figure 3. Lectures for cyber-attack and defend of computer systems.

*B. **Practical** laboratory tutorials for cyber-attack and defending computer networks*

During the practical tutorials students have chance to show what have been practicing and learned during the theoretical part of the course. They have been practicing different scenarios of attacking and defending computer systems and have real time chance to practice network attacks on virtual servers. Using the visualization, that allows exploiting the resources of HPC center, where created virtual servers that have been grouped in teams. In this way the infrastructure resources created with Hypervisor technology that have been

provided by the HPC have been used to create the IaaS service. The mobile cloud computing concept provided with IaaS is used for creating Virtual Labs where students were separated in different teams. The team is created by grouping 4-5 virtual servers, actually located in the HPC center, see Figure 4, that can be accessed anywhere through a Web browser. Students using mobile cloud computing can connect remotely to the Norwich University NUCAS-DF Virtual labs and have chance to participate and involve in computer "attack-and-defend" practical exercises.

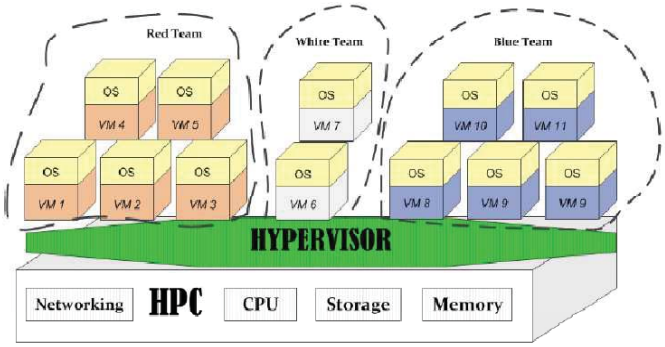

Figure 4. HPC center provided with IaaS is used for creating Virtual Lab Teams

Their *practical laboratory tutorials* required students to send command requests by using network services (FTP, telnet) and protocols (TCP/IP, SNMP, ARP) directly to the HPC center. Every team has to discover the opponents' passwords of the RDP (Remote Desktop Protocol) that uses port 3389 in order to be able to login into the system. Students used "bruteforce" tools to find the passwords, because it requires big processing power in very short time, they *have used the resources from virtual servers of the HPC center.*

In one of the scenarios attacker got only the needed information about what type of system is using "blue team", which ports are opened, and continue to penetrate the ports or to find vulnerability on the system in order to compromise it. Objective of the scenario was for the Red team to attack the Blue team's network defenses, while the White team monitors the progress of both teams. Macedonian students were the Red team, and Norwich the blue team. Within just 90 minutes, the Red team was able to defeat the Blue team by penetrating the system and created a file containing the words: "Hello from Macedonia!". The results from both team efforts from the completed scenario can be noticed in Figure 5. This report shows event overview of vulnerabilities during the interval of attacks presented by event distribution of IP addresses and port used by source and destinations teams.

V. Comparison of Quality of experience (QoE) Evaluation Results

Using the QoE (Quality of Experience) is beneficial to estimate the perception of the user about the quality of a particular service and it depends on customer satisfaction in terms of usability, accessibility, retain ability and integrity of using specific service [10]. QoE means overall acceptability of an application or service, as perceived subjectively by the end-user and represents multidimensional subjective concept that is not easy to evaluate. In our research we have used QoE evaluation in order to measure the quality of achieved learning. Which on the other side represented by the QoL (Quality of Learning) is measurable level of expertise in a given field and context. The process of improvement of QoL in distance learning systems should be supported with increased interaction using teacher scaffolding or as we propose with the benefit of virtual laboratory.

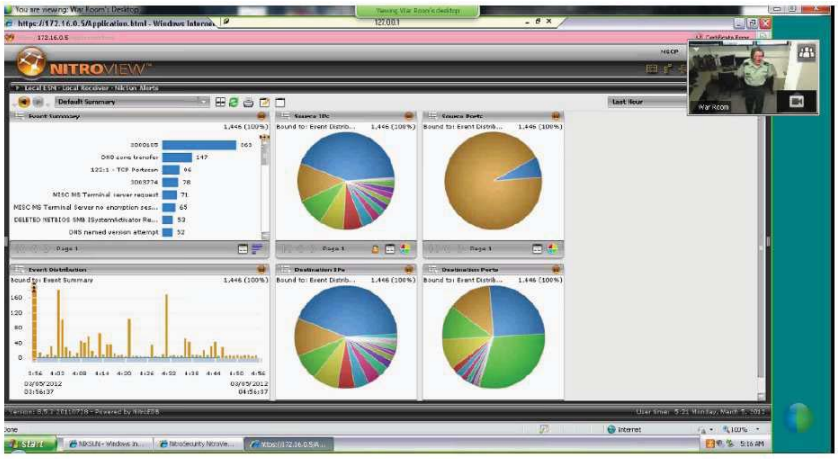

Figure 5. Results from practical training from cyber-attack and defend of computer systems.

The survey questions were answered by a group of 30 students that participated in the distance learning course in area of computer network security. The QoE evaluation was done through answering the following 6 questions after their participation in the distance learning course:

Q1) How available was the learning system (delay or noise) for lectures/practice?

Q2) How easy to use did you find the software that you were using during lectures/practice?

Q3) Did the user focus very easy to the course lectures/practice?

Q4) How interactive is the system for communication with the presenter, Grade the level of interaction?

Q5) What is the student's overall satisfaction in using the system lectures/practice?

Q6) Did you observe educational advantages in the use of this methodology?

The answers from the QoE questions where represented by using the MOS (Mean Opinion Score) scale from 1 to 5 [10]. After the QoE evaluation for the **theoretical** lectures answers are summarized in histogram given in the Figure 6. During the **theoretical** lectures we have not used mobile cloud computing, everything has been done by sharing Power point and using the WebEx annotation tools for teaching the students.

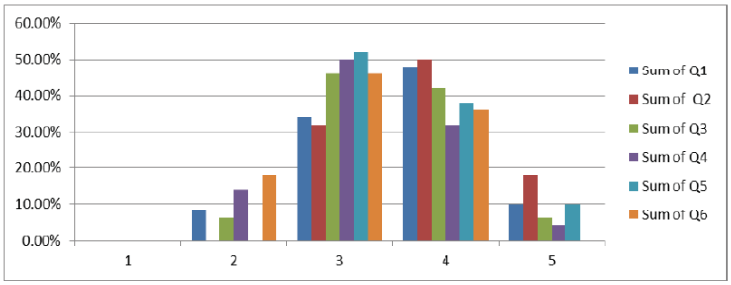

Figure 6. Results QoE evaluation from the *theoretical lectures*

Analyzing the answares from the **practical** laboratory tutorials for cyber-attack and defending computer networks has provided with the summary given in histogram in the Figure 7. Students during the training have been practicing different scenarios of attacking and defending computer systems and used the

benefit of mobile cloud computing. This part of the course has provided the students with higher interaction and collaboration with Norwich University.

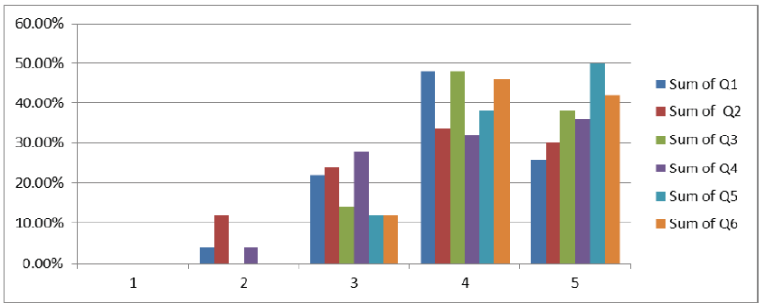

Figure 7. Results QoE evaluation from the *practical lab tutorials*

Summarizing the results percived from QoE evaluation from both parts of the course for cyber-attacks and defending computer networks we can conclude that **practical** laboratory tutorials provided increased students satisfaction and better educational methodology over the **theoretical** lectures.

VI. Conclusion

Using the mobile cloud computing for delivery of augmented multimedia learning courses, we provide advantages such as flexibility, portability and scalability that where obstacles of the mobile devices. The mobile cloud provides users with easier access to HPC centers in order to support their learning and research activities. Observing the results from the QoE survey the educational advantages from using this methodology, mobile cloud computing, have significantly increased students attention. Using the mobile cloud computing technology has provided improvement in the process of distance learning, in the direction of increasing the quality of learning. We expect that these cloud services will be especially beneficial for universities which require from the students to do more experimental and practical work, by promoting the advantages from using the virtual laboratories.

REFERENCES

1. M. Marcelo, “Mobile Learning: Challenges, Perspectives and Reality”. Mobile Learning: Essays on Philosophy, Psychology and Education, Passagen 2003. pp. 151-164.
2. M. Ally, “Mobile Learning: Transforming the delivery of education and training”. Athabasca University Press, March 2009. SC: 978-1-897425-44-2. pp.157-180.
3. S. Xiaojuan, R. Guang-wen and Wang Zhe, “The Application of Cloud Computing SaaS Delivery Model in University Talents Training” Second International Conference on Digital Manufacturing & Automation, 2011. ISBN: 978-0-7695-4455-7. pp. 1203- 1205.
4. M. Saranya and M.Vijayalakshmi, “Interactive Mobile Live Video Learning System in Cloud Environment”. IEEE-International Conference on Recent Trends in Information Technology, ICRTIT, june 2011 ISBN: 978-1-4577-0588-5.. pp. 673- 677.
5. Cloud Architecture. http://sites.google.com/site/cloudarchitecture/ <access on 22/05/2012>

6. N.Mallikharjuna Rao, C.Sasidhar and V. Satyendra Kumar, “Cloud Computing Through Mobile-Learning”. International Journal of Advanced Computer Science and Applications, IJACSA 2010. ISSN : 2156-5570. Vol.1, No.6, December 2010. pp.42-47.
7. M. M. Alabbadi. “Mobile Learning (mLearning) Based on Cloud Computing: mLearning as a Service (mLaaS).” UBICOMM 2011: The Fifth International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies. IARIA, 2011 ISBN: 978-1-61208-171-7. pp. 296- 302.
8. L.J. Zhang, “EIC Editorial: Introduction to the Body of Knowledge Areas of Services Computing”, IEEE Transactions on services computing, Vol. 1, No. 2. April-June 2008. pp. 62-74. http://tab.computer.org/tcsc/tsc2008020062.pdf <accessed on 28/05/2012>
9. Cisco WebEx key features. http://www.webex.com/lp/keyfeatures <access on 19/05/2012>
10. W. Wu, A. Arefin, R. Rivas, K. Nahrstedt, R. M. Sheppard and Z. Yang, “Quality of Experience in Distributed Interactive Multimedia Environments: Toward a Theoretical Framework”, MM '09 Proceedings of the 17th ACM international conference on Multimedia, 2009 DOI: 10.1145/1631272.1631338, pp. 481-490.
11. C.S. Chang, T.S. Chen, H.L. Hsu, “The Implications of Learning Cloud for Education: From the Perspectives of Learners”. 2012 Seventh IEEE International Conference on Wireless, Mobile and Ubiquitous Technology in Education, 978-0-7695-4662-9/12, 2012 IEEE, DOI :10.1109/WMUTE.2012.36, pp.157-161.
12. X. Bai, “Affordance of Ubiquitous Learning through Cloud Computing”. 2010 Fifth International Conference on Frontier of Computer Science and Technology, 978-0-7695-4139-6/10, 2010 IEEE DOI: 10.1109/FCST.2010.109, pp. 78-82.