Private Cloud with e-Learning for Resources Sharing in University Environment

K.P.N Jayasena[1,2] and Huazhu Song[1(✉)]

[1] School of Computer Science and Technology, Wuhan University of Technology, Wuhan, People's Republic of China
shuaz@whut.edu.cn

[2] Department of Computing and Information Systems, Sabaragamuwa University of Sri Lanka, Belihuloya, Sri Lanka
pubudu@appsc.sab.ac.lk

Abstract. Most existing e-Learning platforms are unable to share learning resources between cloud platform and public network, and normally need additional cost to deploy the environment. This paper presents a new e-Learning model based on the virtual private network and private cloud, which could help the student to easily setup and configure his own e-Learning environment with less cost for efficiently sharing resources in universities. Firstly this paper describes the academic private cloud tool that offers a simple environment to experiment cloud computing concepts. Based on this private cloud, e-Learning system can be easily installed by using standard local computing resources, without the need of different hardware or external resources. Hence, this paper illustrates the framework of VPN and Private Cloud Integration, aiming at resource sharing in the university environment. The e-Learning platform is also scalable and capable to interconnect other multi-platform developed in different locations. This proposed framework solves the various challenges faced by e-Learning, and increases the availability, reliability and scalability of cloud based e-Learning systems.

Keywords: e-Learning infrastructure · Private cloud · Virtual learning environments · Virtual Private Networking (VPN) · Virtualization · Resource sharing

1 Introduction

Cloud computing technology is an emerging internet based computing for delivering computing services that are delivered as a service over a network (typically the Internet). The e-Learning solution is one of the technologies which implement the cloud power in its existing systems to enhance the functionalities providing to students.

In this research, we propose to build a framework to utilize the clouds' features in the teaching process in campus network. Since there are several of cloud types and services, we identify the courses that could apply cloud computing

G. Vincenti et al. (Eds.): eLeot 2016, LNICST 180, pp. 169–180, 2017.
DOI: 10.1007/978-3-319-49625-2_21

to their teaching processes. The main contribution of this research is to building private cloud using open source software and combined it with e-Learning system. Private cloud provides universities a secure platform to run e-Learning services; so many industries are planning to implement private cloud. Most cloud based e-Learning platforms unable to share e-Learning services directly on the public university network. We will provide a flexible, efficient infrastructure for the students in campus with the shared resource, and could let the students easily setup, access and use the resource by private cloud. The presented platform is based on virtual private network (VPN) technology. The VPN based private e-Learning platform is scalable and capable to interconnect other working platform developed in university network domain.

The research is organized as follows: Sect. 1 gives background about cloud computing and e-Learning. Section 2 provides cloud adaption in Education and issues in existing e-Learning systems, and introduces challenges of cloud based e-Learning system. Section 3 illustrates the proposed private cloud framework for e-Learning system and finally discusses the how VPN technology integrates in to current e-Learning system.

2 Background

2.1 e-Learning

e-Learning is a hot topic in education field and has been growing fast since the first web based courses in the mid to late 1990s. e-Learning comprises all forms of electronically supported learning and teaching. The 2013 ECAR study of e-Learning discovered that nearly all institutions (98%) have at least some departments, units, or programs with a major interest in e-Learning [1,2].

There are two ways of e-Learning, synchronous e-Learning and asynchronous e-Learning [3]. Synchronous e-Learning contains technology such as video conferencing and electronic white boards requiring students to be present at the time of content delivery. Asynchronous mode includes programmed instruction and tutorials that permit students to work through the screens at their own place and at their own time. Most of the courses available on the network asynchronous model e-Learning system [4,5].

Based on the literature review, some of the benefits of e-Learning are, it allows students to access material when needed and study at their own preferred place, low delivery cost, learners are required to critically engage with the lot of information available, shared learning by allowing interaction among learners from diverse backgrounds and freedom of speech [6].

LMS (Learning Management system), e-portfolios, and e-Learning social networks use more than one-quarter. Eighty-one percent of institutions provide e-Learning course deliver internally, and 87 % provide tech support in-house [7–9].

There is an emergent trend regarding the research of e-Learning or virtual e-Learning platform [10]. There are several education institutes some examples are the Khan Academy Virtual Learning Center of Granada University,

the Open University of Catalonia, the MIT Open Course Ware, and free online courses of Stanford University virtual courses, which are clearly supported by the e-Learning approach. EdX is a joint partnership between the Massachusetts Institute of Technology (MIT) and Harvard University provide online learning to millions of people in the world. EdX will offer Harvard and MIT classes online for free. Harvard Extension School offers many courses for credit over the Internet. The Internet is used to deliver course lectures with video, audio, and multimedia. Live lectures are recorded and made available on demand through "streaming video" technology. Students use technologies to work on exams and homework assignments and to communicate with the instructor and other students in the class [11,12]. Currently, e-Learning systems face lot of challenges. The main challenge is the massive data in e-Learning system. With the growth of resources, the overhead of resource management becomes a key problem with unacceptable increasing costs. e-Learning system needs scalable storage capacity. Cloud computing has been an emergent topic of information technology paradigm. Cloud computing offers dynamically scalable infrastructure supplying computation, storage and communication capabilities as services it can provide tremendous values to e-Learning [13].

2.2 Cloud Computing Based e-Learning

Cloud computing is an emerging technology that have changed the way applications are developed and accessed. They are aimed at computing resources (hardware and software) that are delivered as a service over a network on a scalable infrastructure. According to the definition of National Institute of Standards and Technology (NIST) [14] "Cloud Computing" is a model for enabling convenient; on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) which can be quickly released with minimal management power or service provider collaboration. On-demand self-service, broad network access, resource pooling, rapid elastic or expansion, and measured service are the main characteristics of cloud computing [15,16].

Many Universities are moving to cloud based e-Learning system in a highly efficient way. Cloud based e-Learning system combined with power of Big Data and it offers a powerful and smart system [17,18]. The e-Learning systems can benefit from cloud computing as the follows [19,25]:

[1] Infrastructure: use an e-Learning solution on the provider's infrastructure.
[2] Platform: use and develop an e-Learning solution based on the provider's development interface.
[3] Services: use the e-Learning solution given by the provider.

It allows researchers search and find models and make discoveries fast. The universities can open their technology infrastructures to private, public sectors for research advancements. The efficiencies of cloud computing can help universities keep place with ever growing resource requirements and energy costs. Students

expect their personal mobile devices to connect to campus services for education. Faculty members are asking for efficient access and flexibility when integrating technology into their classes. Researchers want instant access to high performance computing services, without them [20].

Massive Open Online Course (MOOC) is a recent development that is powered by Cloud Computing technology. MOOC promoters (such as 'Coursera' which is known as the 'Amazon of education') offer a wide range of educational programs from leading universities online for free.

Cloud Computing based e-Learning applications that can use IaaS for dynamic storage and compute resources were proposed by Bo Dong. That research describes a general and simple architecture with monitoring, policy and provision modules. Xian Jiaotong University develops BlueSky cloud framework enables physical machines to be virtualized and assigned on-demand for e-Learning systems [2] BlueSky cloud framework combines with load balancing and data caching middleware functions to assist for e-Learning systems [1,11,21,22].

2.3 Private Cloud for Education

Public cloud has been the best solutions for many industries, even today; there are lot of challenges with a public cloud. In a public cloud environment computing resources,services, and applications are delivered to the customer at a pay-per-use scheme. Amazon Web Services and Google Apps are well-known examples of this cloud deployment model. Private cloud offers the security, customization and efficiency for industries while providing scalability and agility in different processes. However public cloud, a private cloud is a dedicated cloud infrastructure that is customized to deliver different services for a specific institute. The computing resources are available only to the specific institute, whether managed internally or externally.

Here are some advantages presented by the private cloud to the education sector. Lower total cost ownership is a clear advantage. Implementation of a private cloud for efficient allocation of resources as every department in the organization flexibly utilizes resources. Universities have to purchase different software products that become resources of the institute. The product might come to its end-of-life then it becomes no value to the institution or is too complex to install and use. In a private cloud environment, only software that is essential for the university is subscribed and used.

2.4 VPN and Private Cloud Integration

In this section, the research focus on providing networking support for enterprise cloud platforms with VPNs. In private cloud architecture allows different cloud services to connect to each other easily. Here, we discuss how can introduce VPN into the inter-cloud computing architecture.

VPN is a virtual private network that uses a public network (usually the internet) to connect remote sites or users together and built on top of existing

physical networks that can provide secure mechanism for data and IP information transmitted between networks. VPN can be used over existing networks, such as the Internet, it can enable the secure transfer of sensitive data across untrusted public networks, such as intra-cloud and inter-cloud in our private cloud e-Learning infrastructure.

3 Methodology

Before implement the cloud based e-learning system first we outline the goals and requirements. When the course is made in e-learning system it should be available more globally and extend educational reach. The users must have a possibility to access educational resources in the private campus domain through private cloud infrastructure. Campus network infrastructure implement in a different network domain and our private cloud framework deploy in another network domain but these two networks must have a flexible and secure communication path. It will provide a flexible, efficient infrastructure for the students and could let the students easily setup, access and use the resource by private cloud.

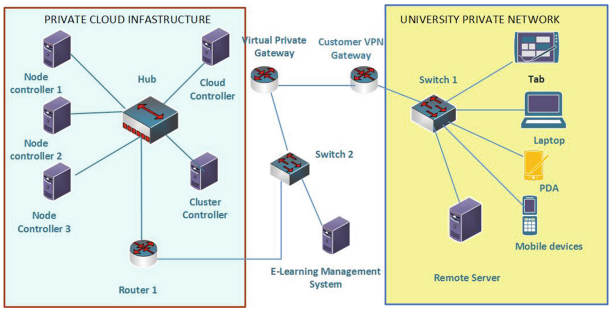

Fig. 1. The overall architecture of the system

The Fig. 1. Illustrates the overall architecture of the system. Overall architecture contains mainly two parts. Most of the e-Learning based researches focus only the private cloud infrastructure.

However in our research we are not going to discuss the private cloud infrastructure other than that we mainly elaborate the virtual private network integration part. Private cloud infrastructure connects with private campus network through VPN technology. In this section first explains the implementation procedure of the Eucalyptus private cloud. The key features of the implemented private cloud include: services for connect to a virtual environment, services for resource management, and services for user account management and a virtual infrastructure management system. These features let for an efficient work with virtual machines. In this virtualization environment students and teachers have

their own storage space in private cloud and they are available for later reference. Students can launch virtual machines instances based on different virtual lab practical. Those instances stored in node controllers private cloud infrastructure. The students are unable to misuse the internet bandwidth as each VM (Virtual Machine) instances is allocated a fixed amount of bandwidth. So this proposed method solve lot of problems arise in existing university infrastructure.

3.1 Implement Private cloud Infrastructure

The main objective of this project is to build a private cloud for the purpose of creating infrastructures and running e-Learning applications. The proposed architecture that builds on top of an existing hardware infrastructure. Implement Infrastructure for virtual e-Learning system, It consists of three layers.

[1] The physical layer: The private cloud architecture is built on top of an existing hardware infrastructure. In this way, all hosts and services can be visualized and managed through a web browser, displaying real-time data about the virtual infrastructure including performance, configuration and storage.
[2] The virtualization layer: In order to allow multiple operating systems to share a single hardware host, a hypervisor is needed.
[3] The service layer: This layer is the interface with the cloud environment, and provides software for supporting the PaaS and the SaaS the cloud users need. In this case, virtual machines are created by choosing base images and software packages. Then students simply access the required VM using the client.

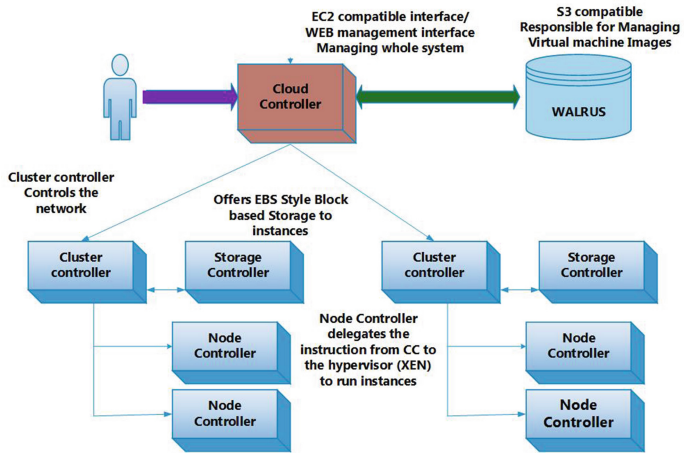

Fig. 2. The overview architecture of the Eucalyptus cloud

The basic architecture of private cloud consists of a front end which runs one or more Cloud Controller (CLC), Cluster Controller (CC), Walrus (WS3),

Storage Controller (SC) and one or more nodes. The architecture of the proposed system is shown in the Fig. 2. The CLC manages the whole cloud and includes multiple CCs. There will be a WS3 attached to a CLC. The CC can contain multiple NCs and SCs. Ultimately the VMs will be running in the NC making use of its physical resource [23,24].

3.2 Implementation of Virtual e-Learning System

In this section mainly consists of three steps, and the virtual e-Learning system is as shown in the Fig. 3.

Create the Virtual Machines. The Eucalyptus Machine Image (EMI) is a combination of a virtual disk image(s), kernel and ramdisk images as well as an xml containing metadata about the image. These images reside on WS3 and are used as templates for creating instances. An instance is a virtual machine deployed from an EMI (Eucalyptus Machine Image). An instance then, is simply a running copy of an EMI. In this research we developed hadoop images for big data analyzing practices for students.

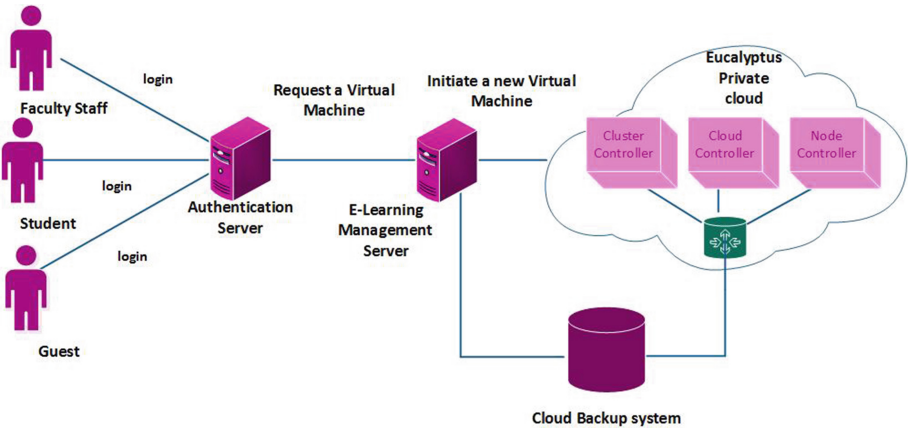

Fig. 3. The virtual e-Learning system

Students lab exercises and practical projects involve hardware with specific software requirements for student projects. Instead of allocating servers and desktop PCs to practical exercises, proposed infrastructure provides virtual machines. For example big data analyzing exercises like Hadoop-based practical sessions each group needs powerful PCs to complete the exercise. Then VMs are most appropriate solution for this purpose. These virtual machines need to be created, managed and monitored automatically. VM created using minimal operating system (OS) images and insert software packages. This system allows

students to reserve any of the enabled VMs for course for which they are registered. In this way, VMs will be available to students during the desired period. VMs with all the necessary software have been geared to students needs depending on the course the student attends. Students can use this software on any computer with an Internet connection and a web browser. After a successful login, the student is shown a list of available VMs, depending on the courses they enrolled. The student can make a reservation for a VM, and choose the date and time when the VM will be used. The reserved VM can be used in the desired time, from any location and any device with an Internet connection and a web browser. It consists of better utilization of existing hardware because the maximum possible number of VMs can be higher than physical hardware exists.

Design the User Interface Layer. This layer will offer all the functionalities that can be used by the different users include teacher, student, administrative staff and others. In this layer we have provided the different learning objects. The main components of this complex application include a set of web services and a web application. Via the web application, the user can review, reserve and use VM placed in the cloud infrastructure. Students can connect to the system from anywhere to work on their practical assignments through different platforms. For teachers improves their works and they can track their students progress and they can create laboratories that can be used any subject.

Managing the Users. User accounts are stored in centralized database implemented using Lightweight Directory Access Protocol (LDAP). LDAP also enables integration with University Information System. Use role based access control (RBAC) to manage user access and permission for that implement LDAP server. A role can be defined as a set of access control grants that can be attributed to an account in the system (e.g. Student, teacher and administrative staff). RBAC system has two phases in assigning a privilege to a user. In the first phase the user (student, teacher) is assigned one or more roles and in the second phase the roles are checked against the requested operations.

Implement the Backup System. In every production system, it is important to be able to restore the system to a working state after an incident resulting in loss of data. The virtual machines can be backed up using the snapshot feature in Eucalyptus. The process of proposed private cloud e-learning solution is shown in the activity diagram in Fig. 4.

4 Implementation of VPN Based Private Cloud e-Learning System

We are developing a system which attempts to meet the requirements of an enterprise ready cloud computing environment using virtual private clouds. This system forces existing virtualization technologies at the server, router, and network levels to create dynamic resource pools that can be connected to enterprises.

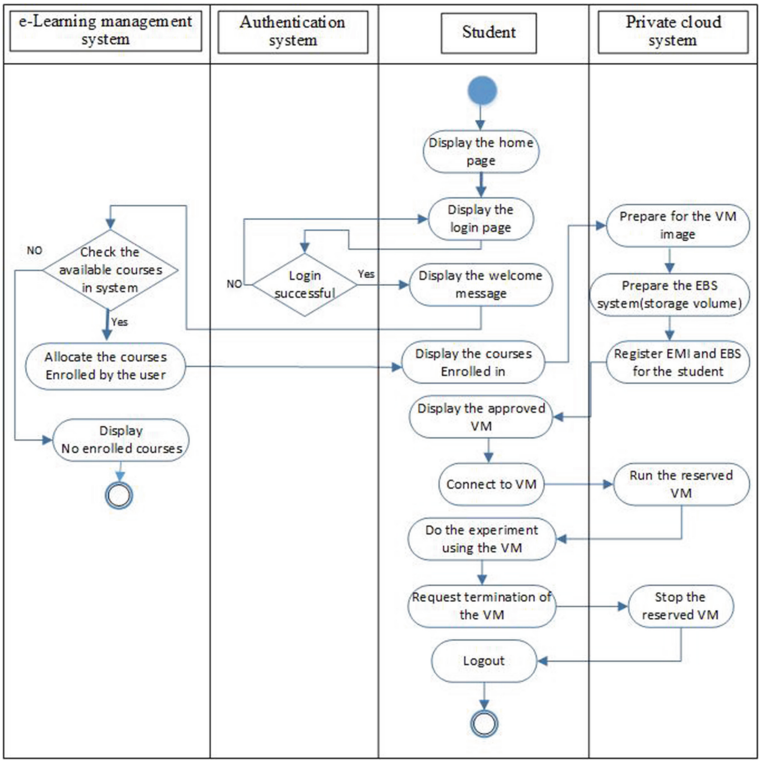

Fig. 4. The activity diagram for the process in the proposed private cloud e-Learning solution

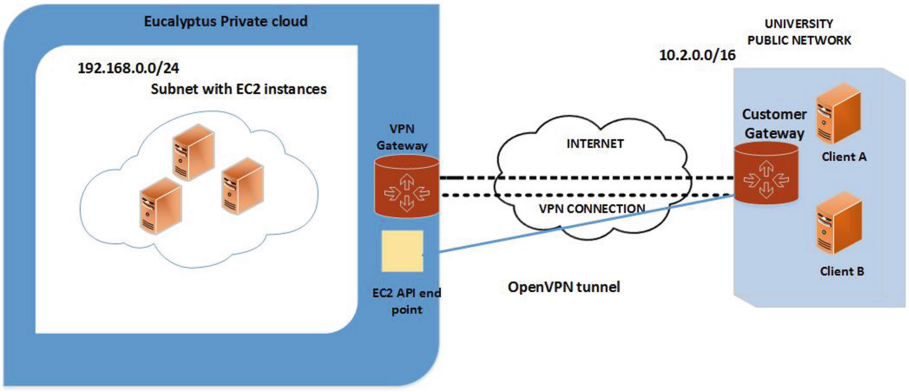

Fig. 5. The VPN architecture in the system

The Fig. 5. Shows the proposed network, the customer gateway, the VPN connection that goes to the virtual private gateway, and the Eucalyptus private cloud. There is a connection between the customer gateway and virtual private gateway. Eucalyptus private cloud contains the EC2 instances, it provides an accurate virtual computing platform which can be created and managed by different users through web service interfaces. Such a virtual environment is used by the students as the platform to achieve all the four lab experiments that designed in the e-Learning environment. It contains VPN server located in the private cloud infrastructure and all the components located in the same network domain. In the above situation private cloud network resides in 192.168.0.0 network domain. The university public network separated from Eucalyptus private cloud network domain. It is situated in 10.2.0.0/16 network domain. Some of the mobile users also located in the university network. The university public network contains customer gateway all the data traffics go through this gateway from private cloud infrastructure. In this section presents a simple setup that allows to an inter communication between local area network to a VPC hosted on Eucalyptus with a private VPN tunnel. The tunneling technology used is OpenVPN. To implement this configuration will need Eucalyptus web services account, Linux server running CentOS on the LAN, one internet connection. Finally we will be able to extend the local area network to a virtual private cloud and interconnect the internal systems with the Eucalyptus cloud instances.

5 Conclusion

The system has established a private cloud-based system for e-Learning, resource-sharing and support for education teachers and students. Private cloud platform that allows large number of distributed resources to become sharable and to be used for e-Learning. IT provides effective and scalable e-Learning services, especially suitable for educational institutions that teach computer science or similar subjects.

In this research, the current status of e-Learning system was discussed and highlights the limitations and determines how we could improve the e-Learning environment for campus environment. After identifying the challenges and limitations, the research showed that Cloud Computing can overcome most of these limitations and challenges to improve the virtual e-Learning environment. The primary focus of this research is to utilize the existing infrastructure which would enable the student to develop and deploy experiment in a real distributed environment, thereby enhancing the students learning outcomes and knowledge base. This cloud based e-Learning system is different from other cloud computing systems, It will connect private cloud server in to local network and access public resources such as objects stored in S3 using public IP address space, and private resources. It provides a flexible, efficient infrastructure for the students in campus with the shared resource, and could let the students easily setup, access and use the resource by private cloud. Students can access the private cloud

system through different platforms such as computer and mobile devices. For that we implement VPN and private cloud integration into e-Learning system. With an increasing growth in the number of users, services, educational contents and resources, the system described in this paper can be used as a model for developing a scalable and flexible infrastructure for e-Learning. The model can easily be adjusted and applied in other educational institutions.

Acknowledgments. The research project is supported by the Education Reform Project(No: w2015043) in Wuhan University of Technology.

References

1. Masud, M.A.H.: A novel approach for adopting cloud-based e-Learning system. In: 2012 IEEE/ACIS 11th International Conference on Computer, Information Science, pp. 37–42, May 2012. http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=6211074
2. Dong, B., Zheng, Q., Qiao, M., Shu, J., Yang, J.: Bluesky cloud framework: an e-Learning framework embracing cloud computing. In: Jaatun, M.G., Zhao, G., Rong, C. (eds.) CloudCom 2009. LNCS, vol. 5931, pp. 577–582. Springer, Heidelberg (2009). doi:10.1007/978-3-642-10665-1_55
3. Alshwaier, A., Youssef, A., Emam, A.: A new trend for e-Learning in KSA using educational clouds. Adv. Comput. Int. J. (ACIJ) **3**(1), 81–97 (2012)
4. Boja, C., Pocatilu, P., Toma, C.: The economics of cloud computing on educational services. Procedia Soc. Behav. Sci. **93**, 1050–1054 (2013). http://linkinghub.elsevier.com/retrieve/pii/S1877042813034319
5. Devipriya, C., Lavanya, K., Priya, M.S., George, S.M.: E-Brainstorm: using PaaS model of cloud for e-Learning. Int. J. Emerg. Technol. Adv. Eng. **4**(2), 368–372 (2014)
6. Madhumathi, C., Ganapathy, G.: An academic cloud framework for adapting e-Learning in universities. Int. J. Adv. Res. Comput. Commun. Eng. **2**(11), 4480–4484 (2013)
7. S. I. Faculty: Cloud-based education, Part 1: E-learning strategy for instructors Concepts, tools, and methods, pp. 1–11 (2011)
8. Benta, D., Bologa, G., Dzitac, I.: e-Learning platforms in higher education. case study. Procedia Comput. Sci. **31**, 1170–1176 (2014). http://linkinghub.elsevier.com/retrieve/pii/S187705091400550X
9. Stantchev, V., Colomo-Palacios, R., Soto-Acosta, P., Misra, S.: Learning management systems, cloud file hosting services: a study on students acceptance. Comput. Hum. Behav. **31**, 612–619 (2014). http://linkinghub.elsevier.com/retrieve/pii/S0747563213002409
10. Button, D., Harrington, A., Belan, I.: E-learning & information communication technology (ICT) in nursing education: a review of the literature. Nurse Educ. Today **34**(10), 1311–1323 (2013). http://www.ncbi.nlm.nih.gov/pubmed/23786869
11. Wang, C.-C., Yen, N.Y.: A sharable e-Learning platform based on cloud computing. In: 2011 3rd International Conference on Computer Research and Development (ICCRD) (2011)
12. Palanivel, K., Kuppuswami, S.: Architecture solutions to e-Learning systems using service-oriented cloud computing reference architecture. Int. J. Appl. Eng. Manag. (IJAIEM) **3**(3), 547–559 (2014)

13. Shahzad, F.: State-of-the-art survey on cloud computing security challenges, approaches, solutions. Procedia Comput. Sci. **37**, 357–362 (2014). http://linkinghub.elsevier.com/retrieve/pii/S1877050914010187
14. Mell, P., Grance, T.: The NIST Definition of Cloud Computing, Recommendations of the National Institute of Standards and Technology (2011)
15. Buyya, R., Vecchiola, C., Selvi, S.T.: Mastering Cloud Computing. Elsevier, New York (2013). http://www.sciencedirect.com/science/article/pii/B9780124114548000103
16. Fox, G., Pallickara, S.: Recent work in utility, cloud computing. Future Gener. Comput. Syst. **29**(4), 986–987 (2013). http://linkinghub.elsevier.com/retrieve/pii/S0167739X13000071
17. Dukhanov, A., Karpova, M., Bochenina, K.: Design virtual learning labs for courses in computational science with use of cloud computing technologies. Procedia Comput. Sci. **29**, 2472–2482 (2014). http://linkinghub.elsevier.com/retrieve/pii/S1877050914004086
18. Ezenwoke, A., Omoregbe, N., Ayo, C.K., Sanjay, M.: NIGEDU CLOUD: model of a national e-education cloud for developing countries. IERI Procedia **4**, 74–80 (2013). http://linkinghub.elsevier.com/retrieve/pii/S2212667813000154
19. Chao, K.-M., James, A.E., Nanos, A.G., Chen, J.-H., Stan, S.-D., Muntean, I., Figliolini, G., Rea, P., Bouzgarrou, C.B., Vitliemov, P., Cooper, J., van Capelle, J.: Cloud e-Learning for mechatronics: CLEM. Future Gener. Comput. Syst. **48**, 46–59 (2014). http://linkinghub.elsevier.com/retrieve/pii/S0167739X14002271
20. Chen, L.-P., Lin, J.-A., Li, K.-C., Hsu, C.-H., Chen, Z.-X.: A scalable blackbox-oriented e-learning system based on desktop grid over private cloud. Future Gener. Comput. Syst. **38**, 1–10 (2014). http://linkinghub.elsevier.com/retrieve/pii/S0167739X14000429
21. Cayirci, E., Rong, C., Huiskamp, W., Verkoelen, C.: Snow leopard cloud: a multi-national education training and experimentation cloud and its security challenges. In: Jaatun, M.G., Zhao, G., Rong, C. (eds.) CloudCom 2009. LNCS, vol. 5931, pp. 57–68. Springer, Heidelberg (2009). doi:10.1007/978-3-642-10665-1_6
22. Honghui, N., Xiaojun, M.: Research of e-Learning system based on SOA. In: 2010 Second International Conference on Multimedia, Information Technology, pp. 148–150 (2010). http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=5474255
23. E. Systems, Eucalyptus 4. 1 User Guide (2015)
24. Togawa, S., Kanenishi, K.: Private cloud cooperation framework of e-Learning environment for disaster recovery. In: 2013 IEEE International Conference on Systems, Man, Cybernetics, pp. 4104–4109, October 2013. http://ieeexplore.ieee.org/lpdocs/epic03/wrapper.htm?arnumber=6722453
25. Despotović-Zrakić, M., Simić, K., Labus, A., Milić, A., Jovanić, B.: Scaffolding environment for e-Learning through cloud computing. Educ. Technol. Soc. **16**(3), 301–314 (2013)