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Research paper



E-learning center of excellence as a service on a private cloud implementation for Jordanian universities

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Abstract

There is a need to design a collaboration infrastructure for Jordanian Universities' to meet their technological needs, use benefit of advanced software to solve a lot of complexes problems quickly and at a lower cost. This paper presents a suggested solution based on cloud computing concepts and describes the structure of the proposed platform to set up an E-Learning center of excellence as service. The authors attempted to offer cloud computing for e-learning service, build a center of excellence in E-learning, and prepare for active exploration model from the following aspects: architecture, construction, and external interface, over and above investigate the factors affecting universities' willingness to use cloud computing in many educational services using quantitative research approach as well empirical studies.

Keywords: *Cloud Computing; E-Learning; Cloud Deployment Models; Center of Excellence.*

1. Introduction

Cloud computing (CC) provides users with the ability to use resources beyond their device capabilities such as processing capacity, storage space and internet applications, at lower prices than if they had purchased these resources. It gives anyone with internet access the opportunity to use resources whenever they need them without having to install new software or buy new equipment. CC emerged as a new economic environment and it is easy to use for all types of users, whether in business, education or even personal use. CC technologies have changed the way of applications development and access [1]. CC has become a technology that can be adopted for many organizations with dynamic scalability and the use of virtual resources as an online service [2]. CC has become a hot spot to research among modern technologies, so researchers pay more attention to their applications. A lot of problems have been studied, such as technology for future distance education in cloud era [3], teaching information system [4], [5], teaching systems development [6], teaching resources integration [7]. On all previous aspects, CC platform provides an effective mechanism to construct E-learning center of excellence as service to overcome many e-learning systems problems. CC has become an attractive technology because of its dynamic scalability and efficient use of the resources; it can be used in limited resource conditions [8]. It has been well-recognized that educational institutions can significantly benefit from CC technology and get benefit of cost reduction, full operation, good maintenance, high management, and out of administrative challenges, all with high satisfactory Quality-of-Service (QoS) [9]. Most of the challenges facing Higher education institutions are to provide IT support to educational activities. Therefore CC is the way out to cover these challenges [10]. Today, Jordanian educational institutions face many problems in coping with changes in information technology and rapid communication, where the development of IT used in the educational and training process requires significant costs for hardware and software requirements. This paper will investigate and demonstrate how Jordanian Universities can take advantage of the evolving CC paradigms in providing high quality, cost-effective e-learning services. A proposed solution will serve all public Jordanian Universities that spread on three regions: Northern region (Yarmouk University (YU), Jordan University for Science and Technology (JUST), Al Al-Bayt University (AABU)); middle region (University of Jordan (JU), The Hashemite University (HU), AlBalqa Applied University (BAU)); Southern region (Mutah University (MU), Tafelah technical university (TTU), Al-Hussein Bin Talal University (AHU)). The reset of paper is organized as follows. Section 2 describes some previous work. A situation analysis is given in section 3. Sections 4, 5 present a detailed description of private cloud implementation for Jordanian universities and a proposed architecture of E-learning center of excellence. Sections 6, 7 describe feasibility assessment and expected benefits of proposed architecture. Finally, a conclusions and future work recommendations are pointed-out in section 8.

2. Previous works

CC is being deployed in many educational institutions; research in this field could be categorized into two groups: education as service and learning as service. In the first group [11] reviewed the latest findings on the use and research of CC in education, taking into account key stakeholders in education, embodying and classifying CC's benefits and risks, identifying and discussing promising technical issues using a systematic methodology, reviewing 112 scientific papers about CC in education until year 2012. [12] Offered an analytical study on the role of CC in education and its exploration as a paradigm shift in teaching and learning processes by focusing on learning and research activities rather than on applying complex IT. CC has much potential to achieve the goal of distance learning. They direct out that Learning as a Service (LaaS) is likely to be brand new CC services in education. [13] Exam-

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ined whether students are required to use software as a service (SaaS), how much they use them, and what types of applications and services they lead. They analyzed and interpreted the results which provide indications of students' willingness to "move to the cloud". [14] Discussed the importance of online training and emphasized its qualitative and quantitative development for some organizations. Focus on using online education based on CC environments. They discussed the need for cloud-based educational systems for organizations and countries. [15] Explains the importance of implementing the CC in the education system, CC's applications in the educational sector can dramatically increase learning opportunities for students around the world and ultimately contribute to providing future generations with the skills and competencies required for career advancements. [16] Studied CC applications as service within their affecting factors. They proposed a regulatory integrating framework derived from CC technology which merged with the dissemination of the innovation theory. Although the proposed framework accelerates the implementation of computing technology but the individual resources or social support are not seen to embarc new behavior. [17] Reviewed the accreditation of CC in education sector in developing countries and Arab countries in particular. Research conducted by [18] interested in developing an effective framework for the Iraqi ministry of higher education and serving all Iraqi universities. This proposal offers some features such as low cost, flexibility, mobility, and business continuity. However, there are still some problems that need further investigations into security, reliability, and loss of sensitive data. Moreover, there is a lack of standards to enable multiple clouds of function as one entity. A survey conducted by [19] showed that cloud computing is still playing an increasingly important role in higher education in the modern world. Higher education deals with cloud-computing services because of economic advantages, increased productivity, improved learning strategies and knowledge penetration. However, there is a debate on various issues such as privacy, integrity, and data ownership. In addition, there is a lack of new security techniques to embrace cloud computing in universities. Various studies in higher education show that the use of computational environments improves the learning process [2], this encouraged [20] to introduce virtualized computing environments based on cloud computing by deploying on-demand infrastructures to support educational activities (ODISEA) platform. The benefits were assessed at a university in Spain. The results show that ODISEA provides students with very high opportunities and strong economic benefits to higher education institutions. Although the platform has a lot of flexibility, it faces challenges because of the complexity of communication between levels. [21] Conducted a survey to analyze the evidence of cloud computing adoption in the education sector. A total of 27 papers were included in the literature review. The results of the study revealed a clear lack of research focused on the use of CC in educational institutions. [10] Proposed CC architecture for higher education institutes that contain CC deployment models, services models, and user domains. In addition, migration strategy was introduced from the traditional system to CC. Although the proposed structure improves flexibility and increases efficiency, but it has not yet been evaluated. CC allows higher education institutions to deal with changing software and hardware quickly and inexpensively. The second group of literature survey, e-learning as service tackled in many articles, these will include, but not be restricted to: [1] claimed that E-learning system based on CC infrastructure is possible and can greatly improve strength of investment and management, which can make the development of E-learning system in a virtuous circle and achieve win-win situation suppliers and customers. [22] explained that it is necessary for an educational and learning organization with its budget constraints and sustainability challenges to use the cloud formations which is most suitable for its IT activities. A cloud computing formation model was proposed based on Cloud Cube Model (CCM) which developed by the Jericho Forum [23]. [24] Focused on the ways of applying cloud computing to transfer traditional to cloud based e-Learning with overall half less costs (i.e. implementation, maintenance, update and re-engineering). [25] Described the concept of e-learning and cloud computing, how to implement it, the efficient utilization of hardware resources and software in a learning environment. [26] Proposed an E-learning model based on CC. They found that the implementation of proposed conventional model is costly, because it takes the cost for providing infrastructure, systems development, and IT team recruitment to maintain and strengthen e-learning systems. The proposed architecture consists of infrastructure, platform, application, access and user layers. [27] Built an e-learning, model based on CC architecture and external interfaces, they considered some pf the benefits of cloud structure of their proposal, but their proposed structure was not evaluated. [28] Proposed cloud computing architecture in the e-learning system which is divided into three layers: infrastructure, platform and application. The prototype of the proposed learning resource model consists of two parts: element classification unit (ECU) and course selection unit (CSU) that reflecting on question and content as a service. The prototype system is evaluated in the form of the message correctness in both type request and response while in verification phase; their communications is tested. The proposed system operates completely and the outcomes are correctly. [29] Described the technological vision of education and cloud computing, how CC can be effectively used in the process of e-learning and sharing the resources of higher educational institutions. [30] Explore how universities and institutions can benefit from clouds. Many case studies address educational clouds provided by popular service providers that reflect the growing interest in this new trend. They also discuss future challenges of cloud education.

3. Situation analysis

The data for this research were drawn from technical and financial requirements for Jordanian universities data centers as well as a technical questionnaire conducted to investigate their situations form all point of views to prepare a suggested solution. From previous sections, it is shown that CC is becoming increasingly important for educational institutions throughout the world, but there are many barriers associated with its adoption which should be eliminated [31]. This paper examines important Strengths, Weaknesses, Opportunities and Threats (SWOT) issues to embrace CC adoption in Jordanian Universities to host e-learning resources, e-services and digital repositories. The paper adopts a SWOT analysis to assess the level of implementation of this technology and provides a framework for adoption and achievement of this technology in Jordanian Universities (JU). The proposing adoption of E-Learning center of excellence (ELCE) for Jordanian universities was the outcome of distributed questionnaire among data centers mangers and policy makers at Jordanian Universities. A questionnaire aimed to identify the SWOT characteristics that will be beneficial for and related to technology usage at JU, where its conclusion and results is shown on table 1. while samples responses to SWOT questions are shown in figure 1. It is clear that the proposed scenario will be a catalyst for the development of e-learning as service in Jordanian universities.

Table 1: ELCE SWOT analysis

Strength (+)	Weakness (-)
Reduce a cost	Lack of enough technical staff
Reducing infrastructure concerns	Post training required
Readiness for SOA	Data transfer bottleneck
Preventing IT violation	Development of applications
Accessibility	
Storability (Backup and Recovery)	
Resiliency and redundancy	
Scalability and expandability	
Opportunities (+)	Threats (-)
Learning new skills	Technological challenges
High interactive ability	Privacy issues
Flexibility of services changes	Security issues
Adaptive to future needs	Compatibility reduction
Offering high tech solutions	Management and control

	issues
Intelligent knowledgeable environments	
Risk reduction	

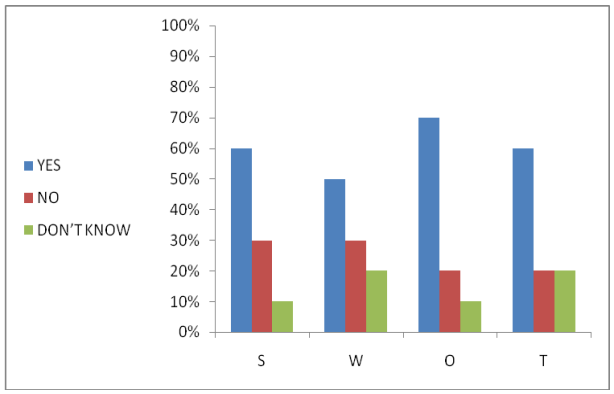


Fig. 1: Outcomes Chart of SWOT Questionnaire in JU.

4. Proposed architecture

Private cloud is proposed to use benefit of existed, developed and maintained services and infrastructure on a Jordanian private network, it could be built on Jordanian Universities Network (JUNET) infrastructure; therefore, the adoption of E-Learning center of excellence (ELCE) could be established on determined regional covered area, i.e. to choose one data center in north part of Jordan as well one in middle another in southern region. According to technical readiness and geographical location, Jordan University of Science and Technology (JUST), Jordan University (JU) and Mutah University (MU) could be suggested for north, central and southern region respectively, where the north part of Jordan covered Irbid, Ajloun, Jerash and Mafraq governorates, central part covered Balqa, Amman, Zarqa and Madaba, while southern part covered Karak, Tafilah, Maan and Aqaba, Figure 2. Using this scenario will raise the availabilities, reliabilities of planning services. This scenario will be used as a redundant infrastructure for all universities members; as well they will use benefit of replication approaches to reduce the service risk.

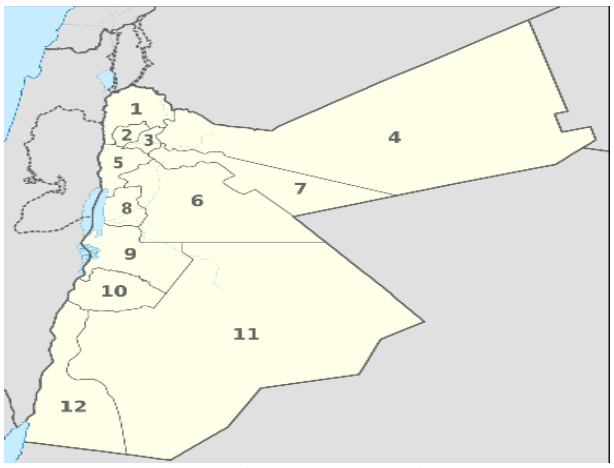


Fig. 2: Map of the Governorates of Jordan.

According to the figure 2, Table 2. shows the universities distribution on the regions; where JUST chosen to be part of private cloud in north, JU in central and MU in the southern part. These three universities will be the core infrastructure of the suggested private cloud, figure 3. The core of proposed infrastructure responsible for various aspects including the operation of the main database services, hosting, maintenance and operation of various equipment on behalf of member universities.

Table 2: Universities Distribution on the Regions

Number	Region	Governorate	University
1	North	Irbid	YU, JUST www.yu.edu.jo www.just.edu.jo
2	North	Ajloun	-
3	North	Jerash	-
4	North	Mafraq	AABU www.aabu.edu.jo
5	Central	Balqa	BAU www.bau.edu.jo
6	Central	Amman	JU www.ju.edu.jo
7	Central	Zarqa	HU www.hu.edu.jo
8	Central	Madaba	-
9	South	Karak	MU www.mutah.edu.jo
10	South	Tafilah	TTU www.ttu.edu.jo
11	South	Ma'an	AHU www.ahu.edu.jo
12	South	Aqaba	-

Suggested universities (JUST, JU, MU) must be fully connected over the Jordanian Universities network (JUNet) after increasing the connection bandwidth and developing their data centers to achieve scalability, persistent storage, efficient use of resources, distributed access and interoperability of the E-learning center of excellence nodes. The proposed private JU_cloud offers greatest level of privacy, security, reliability and control, but it is required the core data centers to purchase and maintain all needed software, licenses' and needed infrastructure hardware which slightly increases the initial cost of proposed cloud.

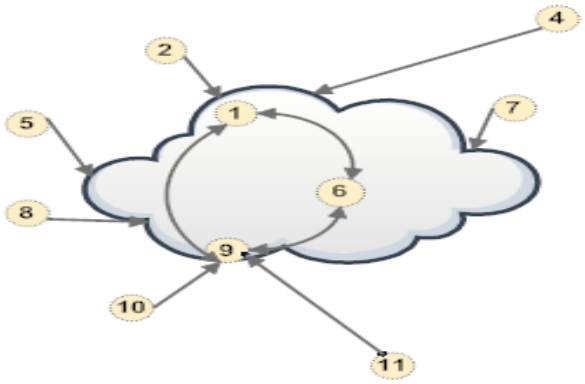


Fig. 3: Proposed Private JU Cloud.

5. ELCE private cloud

ELCE as service will be online learning processes which use the JU's private cloud to design, implement, manage, support and expand learning; it will greatly improve the efficiency of proposing service. Universities will use benefit of designed content, share architecture infrastructure as well use virtualization technology. The JU private cloud is supposed to be a marketing term for computing architecture that provides hosted services such as ELCE, Figure 4. Where advances in virtualization and distributed services environments will allow corporate infrastructure network and proposed data centers as core (JUST, JU, MU) to become a service providers that meet the needs of universities' customers within the company. Proposed scenario ensures that universities focus more on research and learning than on the implementation of a complex IT infrastructure. ELCE will form the foundation of the future IT infrastructure in Jordan to ensure the development of the hardware and software environment. This will be done by strengthening the type of used resources for education and e-learning purposes, reducing costs, enhancing information security and keeping up with updated information.

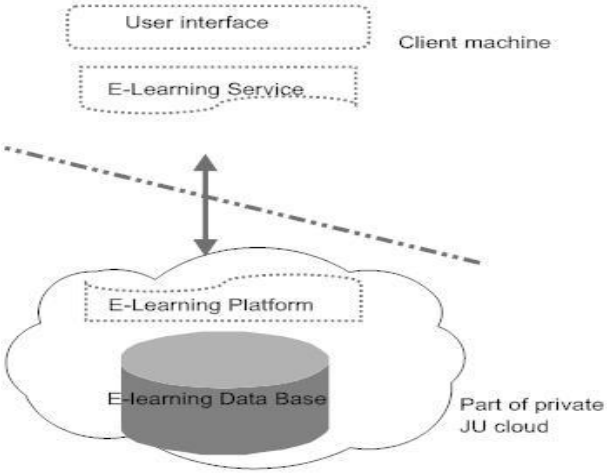


Fig. 3: Part of Private JU Cloud as Service Provider.

6. Technical and feasibility assessment

The proposed solution has been evaluated from a technical point of view and through its technical performance in a simulated and modeled manner using functional testing method. A comparison between simulation and expected results shows that the system will be running properly and it is good scenario in the case of Jordanian universities. It is seen that this scenario will achieve high availability as well more reliability because of a fully connection platform and the data centers redundancies as well as a service replication. According to feasibility study of the proposed architecture, as well as the study of adopted questionnaire and reviewed documents. It found that 90% of needed hardware to establish the solution was existed at nominated universities, while the financial reduction of the proposed solution shown in table 3.

Table 3: ELCE Cost Reduction

Factor	(%) Reduction
Installation Requirement and Connection Cost	20
Development Team Cost	30
Test Cost	35
Capital and Budgetary Improvement	45
Management and Technical Support Cost	30
Training Cost	15
Overall Solution Cost	30

Proposed approach was evaluated from economical aspect according to the approximation cost analysis including capital expenditure and operating expenses for both scenarios none and cloud based solution. It is found that the investment cost decreasing up to 40%. While the net present value of proposed scenario show positive value (55.5%) that means a Jordanian universities will get more benefits from the proposed solution.

7. Expected benefits of proposed architecture

The following advantages derived from the proposed architecture are as follows but they will be checked in future research:

a) High availability through data storage integration and high-performance computing power in proposed data centers; this scenario can provide a high quality service. A private Jordanian Universities CC architecture can automatically detect and exclude node failure, where this scenario will use benefit of redundancy approach and keep the solution n normal operation.

b) Private JU cloud relies on powerful computing and robust storage capacity; thus determining the ELCE architecture and data in a large number of distributed computers, the proposed private cloud based on three data centers provide powerful computing resources, massive data storage space and service to universities staff and students.

c) High level of security. In the JU cloud computing model, data is storied intensively. Relying on the proposed data centers, unified data management, allocate resources, load balance, software deployment, security control, and it is performing reliable real time monitoring, thus ensuring the users' data security to the maximum possible extent. In addition this solution will have it is security circle with all its keys and algorithm suggested by universities which will be hot topic of future research, term of security and privacy in data using some encryption techniques, authentication and authorization.

8. Conclusions and future works

A proposed private JU cloud is a new scenario to producing a solution to many problems. This solution offers many benefits to Jordanian universities such as: managing effectively their technological needs on base of delivery of services providing as well development platforms. They will use the benefits of solution opportunities, and advantages' such as access to file storage, databases, and educational resources as well; it will be a core for many 'as services' and center of excellences in many research fields. Future research will include a study on the migration position and strategy to the proposed structure, from point of views of cost reduction, efficiency increasing, and flexibility of implementation, scalability, accessibility, redeployment and sustainability.

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