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A Proposed Cloud Computing Model for Iraqi's Engineering Colleges and Institutes

Mohamed S. Al-Khayat[1], Mohammad S. Al-Othman[2] , Asst. Prof. Dr. Mazin S. Al-Hakeem[2]

[1]ICT Center, University of Technology, Baghdad-Iraq

[2]Department of Information Technology, Lebanese French University, Erbil, Kurdistan Region, Iraq

A R T I C L E I N F O

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[1]Corresponding Author:
Email:
mohamed.sabah85@gmail.com

A B S T R A C T

Information technology in today's world is no longer considered as an optional set of tools that support the prosperity of various industries but also it has affected all aspects of our life in one way or another. Similarly, the technology of cloud computing which evolved rapidly in all countries including Iraq through the last few years whereby some of the cloud technologies are highly-used by both individuals and organizations in many fields like broadcasting, marketing, health care, education and others. This paper presents some potential advantages of implementing cloud computing at the higher education colleges and institutions of Iraq. Then propose a generic model with six service layers for applying cloud computing technology to support engineering colleges and institutes to be able to implement an educational cloud computing clearly, easily and moving them out of the whirlpool of updating and maintaining their infrastructure. The proposed model allows developers to create flexible and reusable layers and layers with independency to offering efficient services for the students and academic staff, besides saving their time, cost, and effort.

INTRODUCTION

Cloud computing is a kind of Internet-based computing that provides shared processing resources and data to computers and other devices on demand. It is a model for enabling ubiquitous, on-demand access to a shared pool of configurable computing resources (Hassan, 2011). Cloud computing has the possibility to change the IT deployment in corporations and it can change the traditional way of utilizing software and hardware into more attractive services besides providing better design and purchase for hardware (Fox et al., 2009). Hence, different industries are investing in cloud computing in order to improve their business processes efficiency by saving time, cost, and effort. Nowadays, some cloud computing services are so popular like Dropbox, Microsoft SkyDrive, Apple iCloud, Google Drive or Mega Cloud Storage which are used to offer an online data storage (Erl et al., 2013); iTunes, Google Music or Amazon Cloud Player which is used by Apple mobile devices users for playing online Music; Google Docs, Microsoft Office 365, Photoshop Express which are used to access and use services' Applications (Erl et al., 2013); while Google Chrome OS and Jolicloud which are used as a cloud OS (Erl et al., 2013). Education industry and researchers such as others industries also looking for how to exploit cloud computing in developing education environment for students and teachers. Especially because education systems which based on cloud computing can saves budget by

centralized IT infrastructure, quick transfer, flexibility, elasticity, and other Benefits in education field (Paul and DANGWAL, 2014). Since cloud computing offering many resources it could be considered as a tool to develop a new competitive advantage for businesses in general and in specific for engineering colleges and institutions. Therefore, the importance of this paper is represented by taking into account advantages of the cloud computing to propose a generic model of Internet-based computing especially for Iraqi's Engineering Colleges and Institutes, which entered into a spiral of the extensive use of educational technologies and investing time and efforts in buying and maintaining infrastructure which disrupt the aim of establishing effective teaching and learning environment.

In the next section of this paper, we will present a literature review on cloud computing and its implementation in engineering colleges, this is followed by the main cloud computing layers, and in next section we present the main characteristics of cloud computing. Then, the benefits of using cloud computing in education are presented, in addition to adopting cloud computing in education field which is introduced afterwards. Following that, the proposed model of cloud computing. The paper ends with a conclusion and proposed future works.

LITERATURE REVIEW

Cloud computing as a term was largely unknown prior to the 1997 (Chellappa, 1997), it became a buzz word in educational sector after 2007, while many researchers had discussed the failure of universities' presses in the United States to adapt to the opportunities and needs involved in the steady move scholarly works to the digital environment (Brown et al., 2007).

However, Wang and others discussed cloud computing that applied in education informationalization (Wang and Xing, 2011). MD and others explained a roadmap of Cloud Computing for Higher Education which provides with a number of steps for adopting cloud computing (Masud et al., 2012). (Alshuwaier et al., 2012) present different education applications for education infrastructures which are implemented for academic use (Alshuwaier et al., 2012). (Breivold and Crnkovic, 2014) proposed education strategies for teaching Cloud Computing, including key knowledge areas for an enduring Cloud Computing course (Breivold and Crnkovic, 2014). (Elameer, 2015) proposed a strategy for cloud e-learning adoption in the Iraqi higher education sector (Elameer, 2015). (Mansurbeg, 2015) focused on improving education on Soran University campus by using many educational technologies (Mansurbeg, 2015).

Although, many researchers submitted several papers related to using cloud computing in education, but the authors of this paper proposed a generic flexible cloud computing model for engineering colleges and institutions.

CLOUD COMPUTING LAYERS

Cloud computing has its three main renowned layers which utilized for offering different cloud services starting by Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) (Dikaiakos et al., 2009). To make it more clear, in general a cloud computing consists of storage, network, and processing, and cloud architecture composed from the main three layers as shown below (Dikaiakos et al., 2009):

1- The Software or application layer is the highest one and offers applications as a service.
2- The platform layer is the middle which delivers higher abstractions and services to develop, test, setup, host, and preserve applications in the same integrated development environment.
3- The lowest layer is infrastructure, it’s responsible for providing basic storage

and computing features as consistence services over the network such as storage systems, servers, routers, switches and other systems handle specific types of workloads from batch processing to peak loads. Figure 1 displays these three main layer of cloud computing.

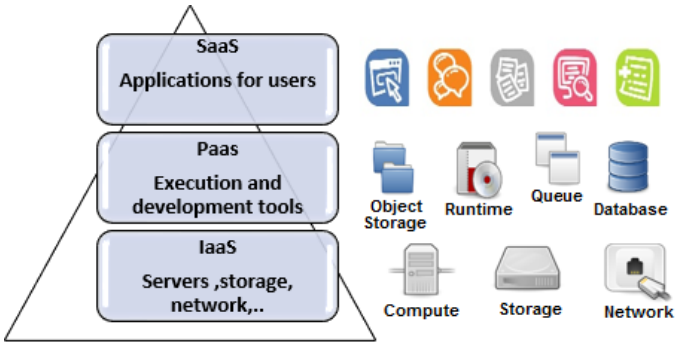

Fig. 1: The Main Three Cloud Computing Layers

In addition to the cloud layers, the cloud computing is classified into four types which are private, public, hybrid, and community clouds. Based on (Jadeja and Modi, 2012) these four types are explained briefly:

- Public Cloud: This type enables the access of public user by a web browser interface and users pays only for the time of using the service like the electricity power system at homes.
- Private Cloud: This type is operating inside the organization data center, and its key advantage is the easiness of dealing with security, upgrading, and maintenance issues. The resources are managed by the organization and only insider users have access to the cloud applications.
- Hybrid Cloud: This type combines both of public and private clouds, whereby a private cloud is linked to one or more external cloud services. It enables the organization to utilize its own resources and when there is a need it is possible to request and use other external resources.
- Community Cloud: This type conducted when many organizations cooperatively joined and shared the same cloud infrastructure. In this case, these organizations could host the cloud infrastructure to a third-party provider or to any one among them.

However, adopting any one of these four types of cloud computing is based on both of situation and needs of an organization.

CLOUD COMPUTING CHARACTERISTICS

There are many characteristics of cloud computing that attract organizations and educational institutes to use and adapt cloud computing. These five fundamental characteristics of cloud are (Mell and Grance, 2011):

- On-Demand Self-Service: This means that a user doesn't need knowledge on setting up and running computing capabilities such as network storage and server time, because these are prepared automatically without a need for human intervention with the service provider.
- Broad Network Access: This means that features and services are available over the network and accessed via standard processes that foster use by different thin or thick client platforms (such as laptops, mobile phones, tablets, and workstations).
- Resource Pooling: This means that the computing resources of the provider are pooled to serve many users using multi-tenant model, with various virtual and physical resources (i.e. processing, storage, memory, and network bandwidth) dynamically allocated and reallocated according to user demand.
- Rapid Elasticity: This means that the resource capabilities can be flexibility prepared and made available to the customer, in some cases it is automatically process to scale rapidly external and internal corresponding to

demand. Regarding the customer, the capabilities available for utilizing and upgrading to be unlimited and could be confiscated in any quantity and at any time.

- Measured Service: This means cloud computing automatically control and optimize resources by using a metering feature at some level of abstraction suitable with the type of service (such as processing, storage, and network bandwidth). The benefit is to control, monitor, and report the usage of resource and to provide transparency for the customer and the provider of the consumed service.

THE BENEFITS OF CLOUD COMPUTING IN EDUCATION

As can be realized from the cloud characteristics which stated in the previous section, the cloud computing has many general advantages in many fields. However, this research focuses on the benefits that cloud computing brings to education field. Many universities are investing in cloud computing for economic issues in addition to better advanced teaching, training, and data sharing (Jeong et al., 2013). Here are several worthwhile benefits for adopting cloud computing in education related to the economy, resource and time conscious, backup, storage, availability and accessibility, collaboration and others, such as:

- Economies, it is the primary benefit for many colleges and institutes. Hardware for such services can be deployed or removed, potentially freeing up valuable real estate. They will pay per use rather than for one underutilized hardware is appealing. Personnel costs can be cut or staff redeployed (Sclater, 2010).

- Elasticity allows colleges and institutes to begin with small-scale services and build them up gradually without significant up-front investment. It also allows for rapid escalations in demand at peak times such as at the start of the academic year or during exam periods. There is therefore no need to plan usage levels in advance (Sclater, 2010).

- Enhanced availability and the ability to access applications from anywhere with less downtime due to the superior resources and skills available to cloud providers, for example, Google offers 99.9% availability for its educational application suite and appears to outperform this target. Students increasingly dependent on online services for learning and assessment should be given the best possible availability (Sclater, 2010) (Katz et al., 2009).

- Lower environmental impact, the cloud computing enables Colleges and Institutes to reduce their own electricity consumption and, in theory, cloud providers should be able to optimize power usage over a group of customers (Sclater, 2010).

- Concentration on core business, allows institutions to concentrate on their core business of education and research (Sclater, 2010). IT staff at a university will not be overloaded and responsible for the maintenance IT infrastructure, moreover, cloud providers will help the university to eliminate of software and hardware license and capabilities (Sharma and Ganpati, 2013).

- End user satisfaction, for students, there are other clear benefits such as (Sclater, 2010) (Katz et al., 2009):
  - Using office applications for free without having to purchase, install and keep these applications up to date on their computers.

- Possibilities for collaboration are greatly enhanced.
- Do not have to worry about backing up or losing data as it should be safely stored in the cloud - with large storage capacity provided for free.
- Data is accessible to them from any location or from a range of devices such as their mobile phone.
- The modern technologies will increasingly allow users to work offline when Internet access is intermittent.

ADOPTING CLOUD COMPUTING IN EDUCATION

Moving towards the cloud computing is not an easy task for big institutions and universities, since it requires sound planning, high investment and other issues that will be stated briefly in this part of the research. For higher education, cloud computing has an important role in enhancing interactivity and sharing among learners, lecturers, and researchers in a cost effective way (Vitkar, 2012). According to (CISCO, 2012), these are the main steps in the direction of adopting a custom-built cloud-computing solution:

- Creating an inclusive cloud strategy**,** here in this first step, decision makers of IT need to identify the suitable cloud strategy and raise questions about security, objectives and architecture. Experts with an extensive experience are needed to work with universities and colleges, their expertise include several technology areas, such as virtualization, service orchestration, and the security that strengthens network architectures.

This strategy also entails three entities (Vitkar, 2012):

1- The students who take online course, take exams, send feedback, and send homework, projects
2- The teachers deal with content management, prepare tests, assess tests, homework, projects taken by students, send feedback, and communicate with students (forums).
3- Staff works on several systems such as (Human Resource, attendance systems, student management system, and Teacher Information Management System (TIMS).

- Designing a cloud-based architectural model, the outcome of this step is an end-to-end architecture design, a roadmap of migrating to cloud, a general control framework, a security technology framework, physical safety and security, and any upcoming cloud services evolution. For example, in this research the proposed cloud model is a part of this phase which aims to move to cloud computing.
- Making the transition to the cloud, to decrease risk through moving to cloud computing, IT departments at universities and colleges must have someone experienced in providing a virtualized architecture, as well as integrated tools, a facilities plan, orchestration integration, workload migration, and staging and validation activities prior to full-scale implementation. After implementing the cloud transition there is a need to optimize the cloud model to achieve the real benefits of cloud computing: lower operating and capital expenses, better business agility, scalability, and responsiveness.

For higher education, the technology should be used to support better education in both classrooms and labs. That means giving lecturers, students, and administrators both the applications and the freedom to do their work and they pay only for the services at the times of their usage.

THE PROPOSED CLOUD COMPUTING MODEL

In this part of the paper, the researchers proposed a generic model that consists of six service layers with many features for adopting and applying cloud computing technology to serve the engineering colleges and institutes. The proposed cloud computing should serve engineering colleges and institutes in offering efficient services to their students and academic staff, besides saving time, cost, and effort for them. As it can be seen in figure 2 below, the model has six main layers which are presented in this section.

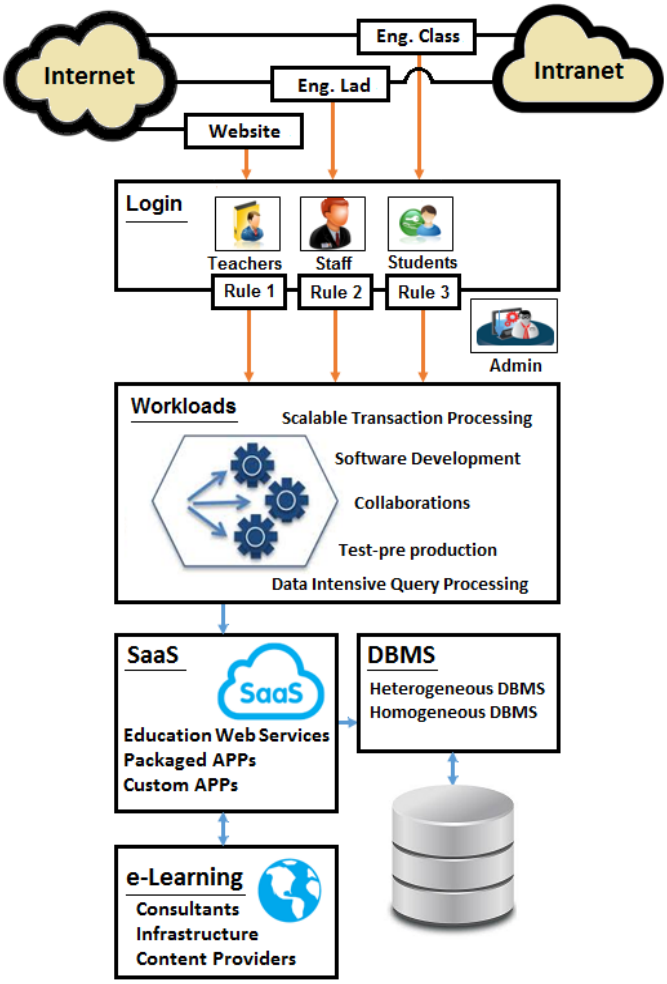

Fig. 2: The cloud computing model for engineering colleges

The type of the proposed model is depending on the implementation of this model, it could either be 'Public Cloud' to operate outside the colleges and institutes, or 'Hybrid Cloud', whereby a private cloud is linked to one or more external services and resources (if already existing inside colleges and institutes). The model's six layers are briefly explained as the following:

1- Locations of Access to Cloud; there are three basic locations to access to the cloud services which are access from engineering classes and labs for users inside the university's campus; and a website for users outside the university's campus. All the users except outsiders can access to the cloud services either by internet or intranet which is an internal network related to a university and intranet offers more security because it allows access to users only from inside a university. Some financial applications require intranet network to be more secured and efficient.

2- Login to the Cloud Services; this layer determines the users of the cloud computing and who have access to its services. These users are system administrator, students, lecturers, and employees. Regarding the guests or outsider users, they are not allowed to access to the cloud services and applications if they don't have any relationship with the engineering college's educational system. In order to reduce the workload on the server from the beginning, the system administrator specifies different authorizations or permissions to different users such as student, lecturers, and employees. The benefit of the authorizations or rules of access is to offer customized services and applications according to the users' categories, since students have some requirements which differ from teachers and employees and the vice versa. For example, when student access to the cloud services they will only have permissions to use the educational applications and only check their marks of different course without being able to modify their marks. Also when employees access to the cloud system, they only can work on the human resources applications

without the permission to see marks of students and modify courses information of the lecturers.

3- Workloads and Information Processing; this layer includes the most important features of the cloud computing that related to workload processing and information processing, here in this model it operates depending on five factors which are collaborations, test-pre production, software development, scalable transaction processing, and data Intensive query processing. All the five factors work cooperatively to process data and information besides distribute workloads on servers before these information getting inside the cloud system.
4- Software as a Services (SaaS) Layer; this layer includes the educational applications, and every engineering department has its own applications. It is the duty of the cloud computing administrator to make sure the availably of the three applications types. These three types are main education web services such as Moodle, secondary packaged applications that support the operation of the main education web services for example Microsoft .NET Framework, and custom applications for both students' and lecturers' researchers such as renting a specific simulation application for a specific time and paying only for the using of that particular period.
5- E-learning Layer; this layer consists of these three factors content providers, consultants, and infrastructure. These factors should be taken into consideration when applying any new applications and services to the cloud computing.
6- Database Management System (DBMS); this is the last layer whereby data and information are moving toward database in the storage devices, and here there is a need for a database management system with its two types heterogeneous DBMS and homogenous. If there is a difference in data types we use heterogeneous to facilitate merging and saving data, otherwise we use homogenous database management system.

The proposed generic model provides a model by which developers can create flexible and reusable layers with independency, for assist the engineering colleges and institutes to implement them educational cloud design easily. So it is possible to add more layers and features for the model without the need to redesign the model or to change the extra layers, functions or application programs.

The six layers of the proposed cloud computing model were described in this part of the research to show how this model works and what types of users are participated in this model, in addition to the applications and services offered by this cloud computing model.

CONCLUSIONS AND FUTUREWORK

Although the using of modern Information and Communication Technologies are the cornerstone of modern teaching and learning in the engineering colleges and institutes in Iraq, but the extensive use of educational technologies and investing time and efforts in buying and maintaining infrastructure was disrupting the aim of establishing effective teaching and learning environment. To face this big problem and to emphasis on quality of education, there should be an awareness about the cloud computing benefits on providing better education services in a cost effective way in addition to make a real investment of cloud computing in providing both software as a service and infrastructure.

The proposed generic model supports engineering colleges and institutes to be able to implement an educational cloud computing clearly, easily and moving them out of the whirlpool of updating and maintaining infrastructure.

This paper tried to make the design of the educational cloud computing comprehensive

and complete. To achieve this objective, the proposed model has been implemented based on cloud computing characteristics. The proposed generic model provides a model by which developers can create flexible and reusable model for assisting the engineering colleges and institutes to implement their educational cloud design easily. Due to the flexibility of the design, it is possible to add more layers and features to the model without the need to redesign the model or to change the extra layers, functions or application programs. This model allows developers to create flexible layers and reusable features with independency.

The proposed generic cloud computing model in this paper opens the door for researchers as a future works to implement many frameworks for improving the education quality of their students and academic staff besides saving time, cost, and effort for them, instead of improving the technical issues.

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