Cloud Computing Adoption by Universities: Concepts and Review

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Abstract: ***Cloud computing considered as new IT technology developed to process the users and organization activities [1]. However, the main objective of cloud computing is to centralized the processes of IT services and infrastructures and gather the information with user's through many applications through internal or external network. Cloud computing is like virtual machine that contain central information, services and hardware as one main system for all employees and departments inside the organization rather than IT system for each sector in the organizations[2]. The initial idea of cloud computing was founded by IBM in 1950's by developed processing machines called "Remote Job Entry" with special features such as speed CPU's and large storages capacity to allow many user's to use the same machine at the same time[3]. Therefore, cloud computing technology developed to provide efficient online services and infrastructure for various organizations to operate and process their activities using external and internal networks without need to install real IT system environment.***

Keywords: Cloud Computing, Information Technology, Cloud Services, Cloud Architecture, Cloud Platforms

1. Introduction

This paper discusses the adoption of cloud computing technology by academic institutes. Thus, the cloud computing reviewing is necessary to understand cloud computing aspects; cloud computing definition, cloud service, deployment approaches, and adoption variables. The paper will review the cloud computing experiment in three academic institutes; Malaysia Universities, Jordon universities and Indian Universities.

2. What is A Cloud Computing?

Until today, there is no standard definition for cloud computing technology due to continues cloud techniques and strategies developments and complicated architecture of different cloud computing field's integration i.e. internet, operating systems and software engineering [4]. Therefore, many researchers and institutions define the cloud computing based on different visions such as service, architecture layers and aims of cloud computing. The most maximal definition of cloud computing is NIST definition which describe the cloud technology as "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) that can be rapidly provisioned and released with minimal management effort or service provider interaction". According NIST detention, the researchers classifies the cloud computing as many concepts; cloud computing services, architecture layers, deployment approaches and purposes [5]. Figure 1 represents the cloud computing definition visions.

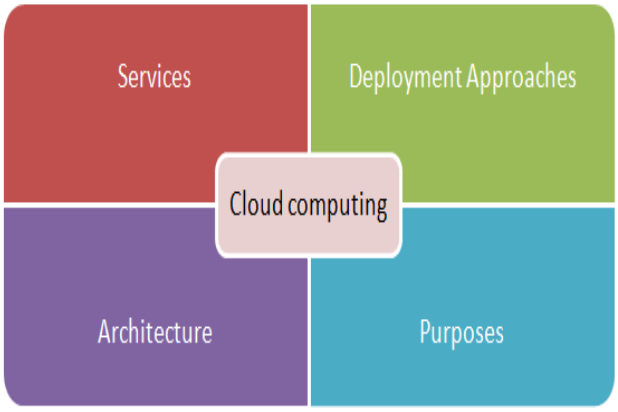

Figure 1: Visions of Cloud Computing Definitions

3. Cloud Computing Service

There are three main cloud computing service; Software as a service (SaaS), Platform as a service (PaaS) and Infrastructure as a Service (IaaS) [6].

A. Software as a service(SaaS) :

This type of services focus on the software and service of IT systems such as recording applications, finical applications and reports applications in various domains like health, education and economic. Therefore, SaaS provide online user's interfaces as connection points between end users and organization services.

B. Platform as a service (PaaS)

The main purpose of PaaS is to manage, control, process and operate the gather information between different applications

and systems storages and infrastructures. Thus, PaaS considered cloud computing operating system to operate the gather information between SaaS and IaaS sides. There are many bold PaaS examples such as online programming language debugger, tasks interruptions management and automated daily operations.

C. Infrastructure as a Service (IaaS):

It is the higher services layer in cloud computing services structure; SaaS represent the infrastructure that responsible about store systems operating systems, applications, data and information and the network requirement to connect between cloud services. Therefore, SaaS considered as systems hardware and storages resources. Figure. 2 illustrate the structure of cloud computing services.

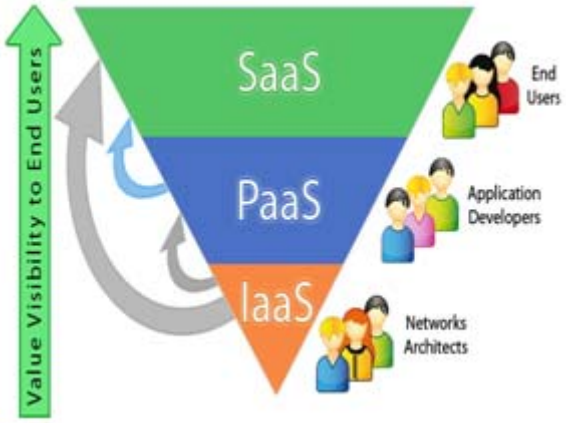

Figure 2: Structure of Cloud computing Services

4. Cloud Computing Deployment Approaches

Most of researchers classify the cloud computing deployment approaches to three main approaches which are; Public, Private, Hybrid; and other researcher added community approach as special deployment approach of cloud computing. However, each of cloud computing deployment approach has its own characteristics such as costs, security and availability, and the organization can decide the suitable deployment approach for its businesses based on working environment. Figure 3 illustrates the cloud computing approaches and characteristics of each approach.

A. Public Cloud

Public cloud is deployment approach that allows organizations or users to use the cloud resources. Therefore, public cloud uses WWW networks as infrastructure to communicate between customers and cloud resources. The main advantage of this approach is globalizing the business markets which give the organization the opportunities to maximize their consumers and publish their products widely [7], [8], [9].

B. Private Cloud

Private deployment approach allows single or many organizations to centralize their services and infrastructure using internal network. Therefore, private approach provides local cloud resources. The main advantages of this approach are reducing the infrastructure and services costs, manage the organizations tasks efficiently and provide high level of data security. However, private cloud is effective for medium and small bossiness which focus on local customers rather than global consumers [7], [8], [9].

C. Hybrid Cloud

Hybrid Cloud is a combination of public and private cloud models or more clouds that try to address the limitations of each approach, but are bound together by standardized or proprietary technology that enable data and application portability. In hybrid cloud, part of service infrastructure runs in private cloud while the remaining part runs in public clouds. Hybrid cloud offer more flexibility than both public and private cloudsv[7], [8], [9].

D. Community Cloud

A community cloud contains features of both the public and private cloud models. Like a public cloud, the community cloud may contain software, data storage, and computing resources used by multiple organizations. Where this model differs from the public model is that the infrastructure is used exclusively by a group of organizations known to each other [7], [8], [9].

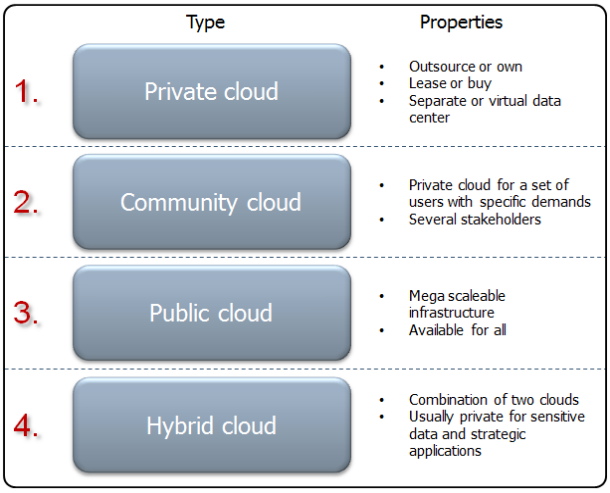

Figure 3: Cloud deployment approach

5. Cloud Computing Adaption Variables

Cloud computing technology offer many advantages over other IT systems due to many characteristics such as availability, accessibility, lower costs and time and tasks management; the main success factor of cloud computing is

resources centralization using external and internal networks. Therefore, cloud computing reduce the money cost of distributed resource, provide service availability and accessibility anytime and anywhere, avoid the work tasks conflictions thorough tasks management as one system rather than many systems and reduce the processing time to collect, retrieve, process and share data and information. The following characteristics are the main variables that represent the cloud computing importance for different organizations in various fields [9], [10], [11], [12], [13], [14].

- Reduce money costs and minimize IT operations budgets: through centralized the software, operating systems, infrastructure and application, IT systems will reduce the costs of IT systems requirement in any organizations.
- Resources availability and accessibility: in traditional IT systems resources like services and infrastructures can used to complete the businesses tasks with in daily works hours, and when the working day ends the IT systems will be offline. On other hand, Cloud computing resources like services and infrastructures available 24 hours per day it can be used anytime and anywhere.
- Reduce processing and tasks time: the traditional IT systems operated based on distribute resources structure. Therefore, the traditional techniques i.e. papers and external storages needed to collect, process, retrieve and share information between organization sectors. Thus, there are wasted time prevent the organizations from provide real time services.
- Tasks and data management: cloud computing technology avoids the responsibilities and roles conflictions between organizations sectors and employees through automatic defining for the permission and roles of each employee and each sector.

6. Cloud Computing Implementation in Higher Educational Institutes

The next three sections will discuss the cloud computing implementations in universities of Malaysia, Jordan and India to clarify the implementations approach, characteristics and benefits of adapting cloud computing technology in higher educational organizations. Table 1 show the main problems of the current systems in each of the three universities and success factors of the cloud computing.

1. Cloud computing in Malaysian Universities

Although, the implementations of cloud computing technology still young in Malaysian universities, there are many practical and theoretical research focus on the challenges of current IT systems in Malaysian universities and the expected benefits of adapt cloud computing as a solution for these challenges. The most findings of cloud computing researches in Malaysia focus on the services availability, accessibility and management of information and activities inside Malaysian universities. However, one of the most important challenges in Malaysian universities is the large number of student's data and information instead of the necessary services and information to support the student's activities [15], [16], [17].

2. Cloud Computing in Higher Education in Jordan

In Jordan universities, the challenges are somehow different than the Malaysian universities. However, the student numbers and services are small compare with Malaysian universities. Therefore, the management problem is not bold issue in Jordan universities; there are two main challenges that lead the universities in Jordan to think about cloud computing which are; reduce the costs and provide services availability. In general, IT systems budgets in Jordan organization are low due to and problems of money resources in Jordan. Therefore, the universities looking for provide efficient services with lowest costs [18], [19].

3. Implementation of Cloud Computing Indian Universities

Educational organizational structure in India is more complex than other educational systems. Thus, the student's records, results and information in middle and high education levels interrelated with each other. In other words, the students accepted in universities based on their results of the last7 years. Therefore, the student's information processing is continues. On other hand, many educational institutions in India still use the papers system to record the information and provide various services. Moreover, the resources costs are bold issue in India due to low budgets of IT systems in educational institutions. The cloud computing technology considered as powerful solutions for various and complex problems of Indian educational institutions [20], [21].

Table 1: The main problems of the current system in universities of (Malaysia, Jordon, India) and the success factors of the cloud computing

University	*Main Problems of Current Systems*	*Current management System*	*Success factors of Cloud Computing*
Malaysian	Difficulty of manage the large data of researches and educational materials to support students activities.	Distributed IT systems.	Educational Resources availability, accessibility and centralization through cloud computing technology lead to maximize the management performances of educational information and students activities.
Jordan	Budgets Limitation of developing IT	Distributed IT systems and paper	Services and infrastructure Availability and

	services and infrastructure to manage the educational activities.	based systems	centralization lead to minimize the needed infrastructure and services to manage the educational activities which reduce the expenses of IT systems development.
Indian	Complexity of the educational structure which need high management requirements such as IT infrastructure and services. Thus, the expenses of traditional management systems are large.	Paper based systems.	The information, services, and infrastructure centralization and accessibility lead to minimize the current expenses and maximize the management level of educational information and services.

7. Cloud Educational Models

This section will explains some cloud computing models for higher educational insinuations. However, the cloud computing adoption controlled by many variables such as management efficiency, infrastructure and services costs and provides services in real time.

7.1 A Federation Model for Education Using Hybrid Cloud Computing

A federation model was proposed in order to bring the advantages of cloud computing assisted instructions into full play. The model showed how an educational application model of software (SaaS), platform (PaaS), and infrastructure (IaaS) leverages multiple independent clouds by creating a federation among the university private clouds and public clouds. A broker mechanism is proposed for better inter-cloud and inter-layer interoperation. The research has significance in constructing more scalable educational application environment based on cloud computing gathering resources from different universities and public providers, also in improving the effectiveness and quality of teaching [22].

Figure 4 illustrates the hybrid federation model architecture and services

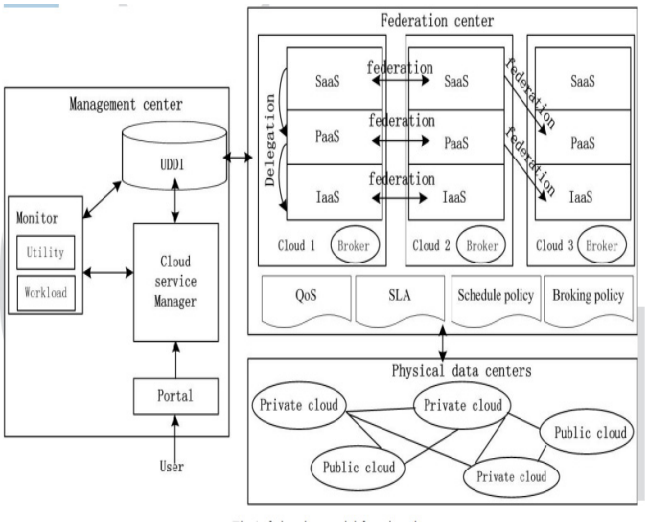

Figure 4: Federation Model for Education Using Hybrid Cloud Computing

7.2 Cooperative Cloud Computing in Research and Academic Environment using Virtual Cloud

This model developed to collect and store the researches and academic works from many university using public cloud services (SaaS and IaaS). Therefore, the cooperative universities of this model can store their own researches and retrieve the researches of other cooperative universities in real time. There are many advantages and characteristics provided by this model such as reduce the costs of researches retrieving and sharing, mange the large volume of researches information efficiently and provide the researches in real time [23]. Figure 5 illustrates the architecture and services of cooperative cloud computing model.

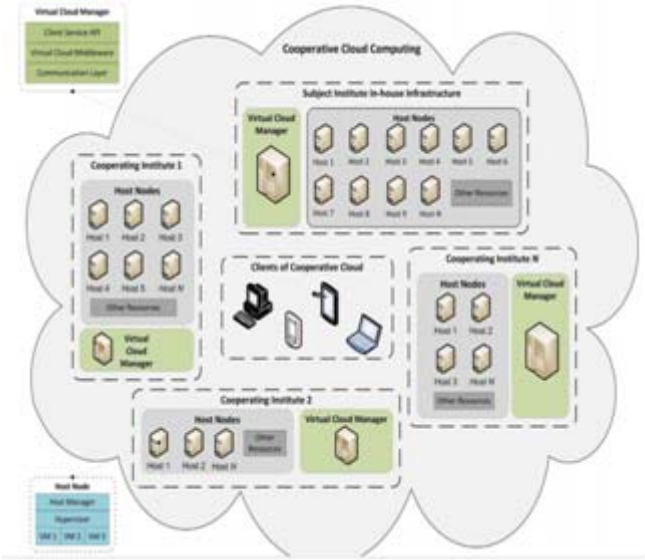

Figure 5: Cooperative Cloud Computing in Research and Academic Environment using Virtual Cloud

7.3 A Service Computing Model based on Interaction among Local Campus Cloud

Conghuan developed this model to process and manage the information of university local departments or nearby campuses effcenently. The main purpose of this model is to manage the universities informarion and activties effeciently. However, there are many conflictions and drabaks in tasks and activities responsabilites management and the large universites need to manage their large volume of information effeciently to retive the needed information of various activites effeciently [24]. Figure 2.11 illustreates the architecture and service of local campus cloud model.

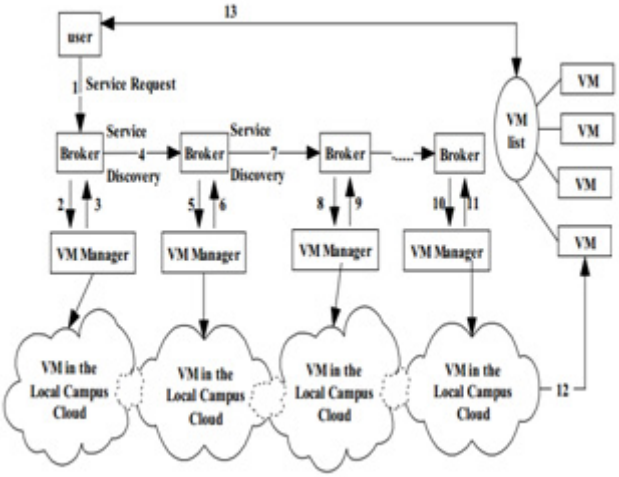

Figure 6: Service Computing Model based on Interaction among Local Campus Cloud

7.4 Summary of Models

The review has chosen three main candidate models: Federation Model for Education under Hybrid Cloud Computing, Cooperative Cloud Computing in Research and Academic Environment using Virtual Cloud, and computing model based on interaction among local Campus Cloud. These models are chosen due to their high uptake by academic institutes. Table 2 compares the three models based on their Specifications such as deployment approaches, cloud services and aims.

Table 2: Summary of Models

No	*Model*	*Year*	*Developing Purpose*	*Cloud Services*	*Deployment Approach*
1	Federation Model for Education under Hybrid Cloud Computing	2012	Share information and service of different universities to reduce services and infrastructures costs and manage universities activities securely and efficiently.	SaaS PaaS IaaS	Hybrid cloud
2	Cooperative Cloud Computing in Research and Academic Environment using Virtual Cloud	2012	Share the researches and academic works between the universities from many counties.	SaaS IaaS	Public Cloud
3	computing model based on interaction among local Campus Cloud	2011	Manage the large volume of information of different university department or campuses efficiently to retrieve the necessary information in real time.	SaaS PaaS IaaS	Private Cloud

8. Future work

There are many Iraqi educational organizations like universities still use the traditional management systems to manage their activities through IT resources. The costs and management issues are the main challenges that face the traditional systems like paper based systems and distributed IT systems. On the other hand, there are money variables of Iraqi universities environments need to be measured to ensure efficient converting from current systems to new systems such as cloud computing systems. Thus, the quantitative and qualitative data need to be collected to analyze the current costs and management challenges of Iraqi universities and the most efficient features and characteristics of cloud computing to avoid these challenges; the data analysis will be helpfully to develop efficient cloud computing model for Iraqi universities. However, there is no clear research focus on develop cloud computing model to maximize the management of the Iraqi

universities and reduce the expenses of current traditional systems.

9. Conclusion

The cloud computing technology provides many features to maximize the performance outcomes of academic institutions; cheap and convenient for information processing of different levels of schools. Cloud computing contain many efficient services process, manage and structure the environments of educational institutions which lead to huge costs saving in IT and human resources and speed up the daily activities through provide the services, data and information at real time.

Reference

[1] Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Cloud Computing: Principles and Paradigms. New York, USA: Wiley Press, pp. 1–44, ISBN 978-0-470-88799-8, 2011.
[2] Amy Schurr, Keep an eye on Cloud Computing, Network World, 2008.
[3] Peter Rossi, IBM Private Cloud Solutions, IBM Corporation, 2011.
[4] M. Malathi, Cloud computing concepts, Electronics Computer Technology (ICECT), 3rd International Conference on IEEE, 2011.
[5] Peter Mell, and Timothy Grance, The NIST Definition of Cloud Computing, Recommendations of The National Institute of Standards and Technology, 2011.
[6] Sumit Khurana, and Anmol Gaurav Verma, Comparison of Cloud Computing Service Models: SaaS, PaaS, IaaS, IJECT Vol. 4, Issue Spl – 3, ISSN: 2230-7109 (Online) | ISSN: 2230-9543, 2013.
[7] Brad McMillan, Cloud Computing: What It Can Do for Your Business, Entrepreneurial Practice Review, Vol 2, No 1, 2011.
[8] Qi Zhang, and Lu Cheng, Cloud computing: state-of-the-art and research challenges, *Journal of Internet Services and Applications* , pp. 7-18, 2010.
[9] Bhaskar Prasead Rimal, Eunmi Choi, and Lan Lumb, I., A Taxonomy and Survey of Cloud Computing Systems, Networked Computing and Advanced Information Management, Fifth International Joint Conference on INC, IMS and IDC, pp. 44-51, 2009.
[10] Bennet Gustafson, and Alexander Orrgren, Cloud Computing: The Adoption of Cloud Computing for Small and Medium Enterprises, Jonkoping International Business School, Jonkoping University, 2012.
[11] International Data Corporation (IDC). (2013, 2, September). Cloud computing forecasting, Avaliable: http://blogs.idc.com/ie/?p=543.
[12] Gartner. (2013, 4, September). Press release: Gartner Says Worldwide Cloud Services Market to surpass $68 Billion in 2010, http://www.gartner.com/newsroom/id/1389313.
[13] Alexander Benlian, Thomas Hess, and Peter Buxmann, Drivers of SaaS-Adoption – An Empirical Study of Different Application Types, Business and Information Systems Engineering (1:5), pp. 357-369, 2009.
[14] Murgasan, Cloud Computing Gives EmergingMarkets a Lift, IEEE IT Professional, volume 13 (issues 6), pp. 60-62, 2011.
[15] Razak S. F. A., Cloud Computing in Malaysia Universities , IEEE, pp. 101-106, 2009.
[16] Thomas, P.Y., Cloud Computing: A potential paradigm for practisingthe scholarship of teaching and learning. 2009.
[17] Malaysia, M.o.H.E., Guidelines on Criteria and Standards forBachelor Programmes at The Degree Level (Honours), Q.A.Division, Editor. 2002, Ministry of Higher Education Malaysia:Putrajaya.
[18] Samah A. Massadeh, and Muhammad A. Mesleh, Cloud Computing in Higher Education in Jordan, World of Computer Science and Information Technology Journal (WCSIT), ISSN: 2221-0741, Vol. 3, No. 2, 38-43, 2013.
[19] B. Sotomayor, R. S. Montero, I. M. Llorente, and I. Foster, Virtual infrastructure management in private and hybrid clouds, Internet Computing, vol. 13, no. 5, pp. 14–22, Sept 2009.
[20] G. Bhatia, Implementation of Cloud Computing Technology in Indian Education System, IEEE*, 2012*.
[21] Gaurav Bhatia, Ajay lala, Ashish ChaurasiaImplementation of cloud computing technology in 1 ndianrailways IPCSIT Volume37 pp. 84-88, May 2012.
[22] Donlin Chen, Mingming Ma and Qiuyun Lv, A Federation Model for Education under Hybrid Cloud Computing, International Confererence on Future Computers in Education, Vol 23-24 , pp. 340-343, 2012.
[23] Sheheryer Malik,Fabrice Huet and Denis Caromel, Cooperative Cloud Computing in Research and Academic Environment using Virtual Cloud, IEEE, 2012.
[24] Ye Conghuan, A Service Computing Model Based on Interaction Among Local Campus Clouds , IEEE , pp 416-419, 2011.

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