Mobile Cloud Framework Architecture for Education Institutions

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***Abstract*— Cloud computing is a relative new technology that has various advantages, including specific applicable to education. In this paper, we discuss the influence of cloud computing on learners, teachers and educational institutions. Cloud computing, especially with relation to mobile learning, will improve the current institutional system of education, and also the quality and affordability of education. Mobile learning, which is a learning model that blends wireless technology and mobile computing, are introducing a cultural shift. The main output of this paper is a conceptual framework for educational cloud architecture design. In South Africa, with its low number of personal computers per capita, but high number of mobile phones, utilizing cloud computing in education is ideal, since it allows the access of education resources to a high number of learners. However, certain challenges are faced, including the lack of relevant and content specific education resources.**

Keywords—cloud computing; mobile devices; education; component; formatting; style; styling; insert

I. INTRODUCTION

Cloud computing has been one of the most important "new"information technologies in the last decade. This is mainly due to the flexibility of information processing it allows. For businesses, governments, educators and learners, it provides the opportunity to access resources anywhere and at any time. Furthermore, cloud computing plays a vital role in the smart economy, enabled by regulatory changes in Web-based business applications[1],[2],[3].The main advantage of cloud computing, is that it provides for low cost application implementation within a low cost infrastructure, both for consumers and producers of information. Some higher business units like Google and Microsoft, are actively offering cloud-based applications and storage for free. This is ideal for educational use, since most learners do not have the financial means to pay for computing resources. In this paper, we provide background to cloud computing in section II, introduce the mobile-cloud computing architecture in section III, and discuss the research method in section IV. In section V the results are presented, concluding in section VI with a discussion and conclusion.

II. BACKGROUND

Currently, there is no standard definition for cloud computing. In this section, we try to clarify what cloud computing is. Cloud computing is Internet-based technology [4], [5] which provides computational resources via a computer network. This allows for provides flexible, scalable, and on-demand services to the end users by centralizing the storage and computational processing. It is especially storage facilities, referred to as "big data", and "limitless" computing power that makes cloud computing so desirable [6]. Cloud computing allows the user to move beyond a single computer, into a truly networking and inter-connection area of computing [7]. No more is the physical location of files or processing power of concern. For example, the user is no bounded to a specific desktop or flash drive, but instead focuses on the availability of Internet connection(s) and service providers. Specifically, services in the cloud are provided by Cloud Service Providers (CSPs), which assure runtime performance and storage space requirements [8],[9].

Services provided by CSPs can be classified into three basic layers, namely applications, platforms, and infrastructures [10]. Each of these services provides specific functionalities to users. In recent years, the availability of cloud-based resources has also increased dramatically, making the business model of CSPs financially viable. However, there is currently no comprehensible definition or standard for cloud computing that all CSPs agree upon. Each provider utilizes terminology based on their own product's portfolio [12], of concern when inter-operability is considered. A simple illustration of cloud computing development is shown in Figure 1.

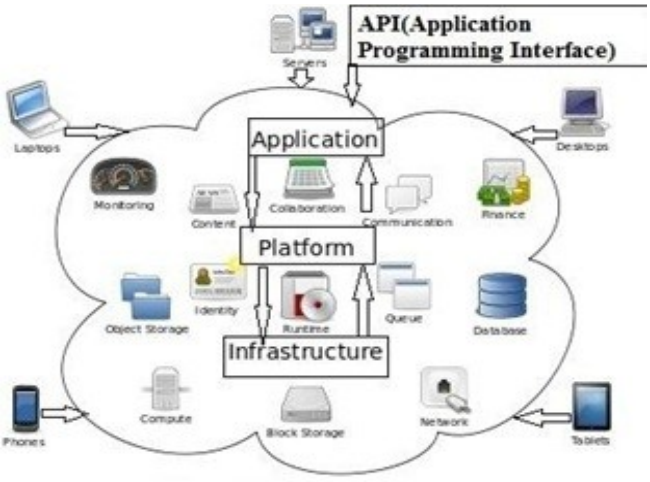

Fig. 1. Cloud Computing Development

The term cloud computing is being branded as the future of information technology, mainly based on the importance of Web 2.0 in electronic-commerce, electronic-government, electronic-learning (e-learning) and electronic-social. Clearly,

society has change to be more depended on technology than ever before. But cloud computing potential doesn't begin and end with the personal computer, laptop and notebook. More and more personal communication devices like smartphones are developed with application closely linked to cloud computing. ABI Research, in a recent research report, theorized that cloud computing will soon become a disruptive force in the mobile world, eventually becoming the dominant way in which mobile applications operate [13].

The economics of cloud computing provide a compelling argument for mobile learning. Cloud-based applications can provide students and teachers with free or low-cost alternatives to expensive, proprietary productivity tools. For many educational institutions, cloud computing offers a cost-effective solution to the problem of how to provide services, data storage, and computing power to a growing number of learners. These capabilities all can serve as a "new" and exiting disruptive technology in the education discipline.

III. EDUCATIONAL ENVIRONMENT

Current computer science educational environments are traditional and often unable to face the demand of rapid changes in technologies. This is also true for e-learning technologies, which appears to have numerous limitations based on institutional resources and lecturer's e-skills. In addition, infrastructure limitations often force institutions to avoid using multimedia content due to its high cost. Educational institutions thus often minimize the use of sophisticated educational e-learning platforms. This research intends to create a framework for computer science education to reduce the number of limitations and challenges, specifically by implementing cloud computing. The framework removes locality constraints, allowing students and institutions to collaborate in a distributed and interactive surrounding. In addition, cloud computing provides a set of tools to help educators explore subject complexities in a manageable manner[14].The envisage cloud-based e-learning environment would be stable, hold massive amounts of data, enable the use of sophisticated software and basically reduce any concerns regarding institutional infrastructure limitations.

IV. MOBILE LEARNING

Mobile learning or m-learning, already enable by technological devices like smartphones, can greatly benefit from the resources available in cloud computing. As such, m-learning allows learners the ability to share resources at anytime and at anyplacet [15]. To be able to access resources utilizing m-learning, a learner will have to register and get credentials, necessary to use it via web. An example can be the institutional learning management system. Another access method to resources will be through utilizing mobile application (apps), downloaded to the phone, which will then access the cloud as required. This would imply the use network technologies like GPRS and WIFI. Currently, most students prefer the use of WIFI connections, since they are provided for free at most campuses. Educational resources like documents, podcasts, videos, can thus access without any financial considerations. This is especially relevant in the South African context, based on historical factors.

It is important to note that cloud computing is classified as a disruptive technology. This implies that it will have a major impact on educational practices, if utilized. Furthermore, while there are currently less mobile applications for cloud computing then personal computer based applications, many cloud-based applications are in development. We postulated that mobile-cloud computing will become the predominant way that mobile applications function in the future. The largest advantages to mobile-cloud computing can be stipulated as follows:

- **One Application for All Devices**: Applications hosted in the cloud eliminate the requirement that the application be tied to a single cell phone service provider or mobile phone.
- **Capabilities Boost**: Mobile devices do not have the processing power or memory space required on the device itself for intensive applications. Cloud computing provides a tremendous leap in functionality and the amount of data the application can access.
- **Data Not Tied to the Device**: Mobile devices fail, are lost or sometimes destroyed. However, with cloud computing critical data is preserved, since it is stored in the cloud, not on the device.
- **Low Cost for Set-up and Maintenance**: Users only pay for the infrastructure they use. Institutions and learners can easily scale applications and avoid the hassle of maintaining servers and equipment.

V. MOBILE-CLOUD COMPUTING ARCHITECTURE

The main goal of the proposed mobile-cloud computing architecture is to provide a proxy for mobile clients to connect to cloud services. Figure 2 depicts an overview of the proposed mobile-cloud computing architecture and its main features.

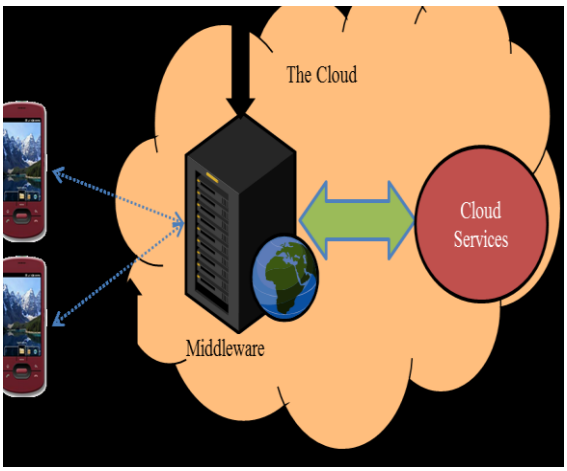

Fig. 2. Mobile-Cloud computing Architecture

As such, the proposed mobile-cloud computing architecture consists of three parts, namely the mobile client, the middleware and the cloud services. Since cloud services are usually controlled by CSPs, while the middleware are

responsible for all the necessary adaptation for mobile clients that are required. For example, some services require real-time updates like blogs, twitter services, videos and RSS feeds. The middleware are also responsible to push updates of services to mobile clients. Finally, the mobile client is the mobile technology to which the user has access, normally in the form of a feature phone or smartphone.

VI. Mobile-Cloud Computing Architecure for Education

In this proposed mobile-cloud computing system, the main foci is the minimization of previous limitations of e-learning, by utilizing the advantages of cloud computing. Educational cloud computing is designed so that it can support learner, providing in all user requirements for processing and data store. Everything the learner may need is provided in and by the cloud. Furthermore, the learner only pays for what he uses, not for that which he or she does not use. This mobile-cloud computing system furthermore allows various devices to access resources, not only smartphones, as depicted in Figure 3.

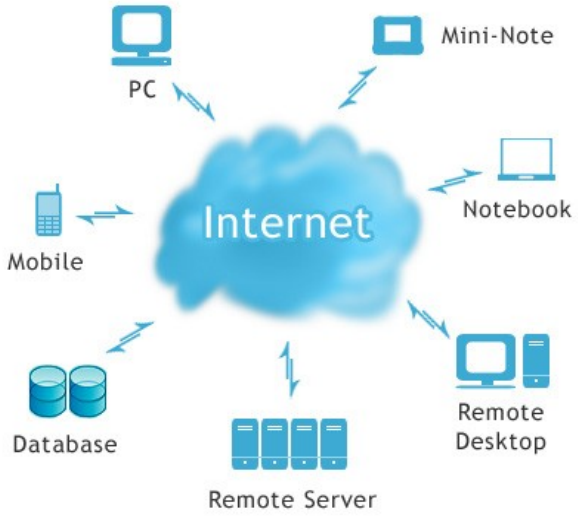

Fig. 3. Education Mobile-Cloud computing Architecture

VII. Research Method

A quantitative research approach was used in this study to measure lecturer and learner attitude towards mobile learning, specifically based on the mobile-cloud computing architecture. Quantifiable as survey, a questionnaire was used to measure the attitudes of participants relating to usefulness, significance, effectiveness and social networking and communication.

Participant were all associated with the Vaal University of Technology, specifically the department if Information and Communication Technology. Convenient sampling was employed, thus making it non-random sampling, limiting the generalization of studies results.

VIII. Results

The questionnaire employed required participants to answer six questions. These questions and results are depicted in Table I.

Questions and Results (A=Agree, D=Disagree, SA=Strongly Agree, SD=Strongly Disagree)

TABLE I. Questions and Results (A=Agree; D=Disagree; SA=Strongly Agree; SD=Strongly Disagree)

Question	A	D	SA	SD
Mobile-Cloud Computing Framework is useful for education	**40%**	**15%**	**25%**	**20%**
Mobile-Cloud Computing Framework is significant in education	**30%**	**20%**	**25%**	**25%**
Mobile-Cloud Computing Framework is effective in education	**28%**	**26%**	**24%**	**22%**
Mobile-Cloud Computing Framework will improve social networking and communication for education	**35%**	**20%**	**25%**	**20%**
Mobile-Cloud Computing Framework is a technology for the future	**40%**	**20%**	**25%**	**15%**
Mobile-Cloud Computing Framework will change education	**40%**	**20%**	**30%**	**10%**

IX. Discussion and Conclusion

Results indicate that in general, lecturers and learners were in agreement that mobile-cloud computing will be an important technology for education in the future. As such, the use of mobile-cloud computing architectures or frameworks [16] will ensure the effective implementation of mobile-cloud computing. However, the use of mobile-cloud computing architectures or frameworks will require reviewing educational structures and redistributing services, based on the course requirements. Mobile learning systems will enable learners and lecturers access to educational resources anywhere and at anytime, while ensuring control by educational institutions. Learners have the opportunity to access course material and recourses, assignments, presentation and relevant communications, including newsgroup, chat and e-mail. Lecturers again have the capability to provide instant feedback to student assignments and queries.

Mobile-cloud computing architectures have the potential to significantly impact not only on society in general, but also on educational institutions and current teaching and learning strategies. Presently, e- and m-learning are becoming ever increasing popular, not only in formal learning, but also in informal learning. The development of a mobile-cloud computing architecture for education can assist in the developmental process of transforming education into the “net generation”.

In effect, the educational experience of learners will improve, indicated by the positive results obtain in this study. Although this paper did not full address all the relevant aspects related to the design and development of a mobile-cloud computing architecture, it is envisage that, as the project continues and implementation of a m-learning solutions is implemented at the Vaal University of Technology, even more positive results will be presented. It must, however, be accepted that new technologies, especially disruptive technologies, will face opposition from parties in and outside educational institutions.

Mobile-cloud educational applications will help not only new "net generation" learners in the future, but also lecturers, administrators and institutions. It will enable the merging of formal and informal learning into a new and connective way of learning, introducing concepts like personal learning environments and massive open online courses, the first of which are already evident in progressive educational institutions.

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