CLOUD COMPUTING IN EDUCATION IN THE MIDDLE EAST AND NORTH AFRICA (MENA) REGION: CAN BARRIERS BE OVERCOME?

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Abstract: Interest in Cloud Computing (IaaS, PaaS, SaaS) in the e-learning arena is growing due to potential greater cost savings from scalable architectures and open source products, and the possibility of higher learning outcomes. Greater connectivity between centralized server-side applications and low cost/low processor capacity mobile devices (M-learning) could provide better access, more control, and greater freedom for e-learners. Many United States businesses and governmental agencies are outsourcing organizational functionality such as email to such Cloud systems as Gmail and Google Apps. However, some serious issues with the viability and suitability of the Cloud Computing model for education remain: primarily, storage of sensitive data on third-party servers outside of the organization. Family and individual privacy are important cultural values in the Arabian Gulf. Also the loss of data through discontinued Cloud services has not been uncommon.

Keywords: E-learning and Cloud Computing, Gulf Cooperation Council (GCC), Arabian Gulf (Qatar, Bahrain, Kuwait, UAE, Oman, Saudi Arabia).

I. INTRODUCTION

Interest in Cloud Computing in the e-learning arena is growing due to potential greater cost savings from scalable architectures and open source products, and the possibility of higher learning outcomes. Greater connectivity between centralized server-side applications and low cost/low processor capacity mobile devices (M-learning) could provide better access, more control, and greater freedom for e-learners. Many United States businesses and governmental agencies are outsourcing organizational functionality such as email to such Cloud systems as Gmail and Google Apps. However, some serious issues with the viability and suitability of the Cloud Computing model for education remain: primarily, storage of sensitive data on third-party servers outside of the organization. In some MENA countries, governments attempt to control the flow of information for social and political reasons. Student data in Course Management Systems (CMS) needs to be carefully protected. To provide one simple example, in the socially conservative Gulf region (where females are reluctant to be photographed), the accidental or malicious release of a female student’s photograph into the public domain could have large consequences for her, her family, and the institution or third-party that mishandled this data. This contribution looks at the benefits of Cloud Computing with respect to e-learning in the MENA region and potential barriers to widespread adoption of this model.

1.1 Definition of Cloud Computing

Vacquero et al. supply a concise overview definition of Cloud Computing: “Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization. This pool of resources is typically exploited by a pay-per-use model in which guarantees are offered by the infrastructure Provider by means of customized SLAs” [1].
The following more detailed definitions of Cloud Computing are drawn largely from the exposition of Al Jumeily et al (2010) [2]. Cloud computing can be broken down into 3 major components:

- **IaaS - Infrastructure as a Service** comprises the layer of storage, hardware, servers and networking components. The supplier maintains and upgrades these resources and the user pays for the service depending on the amount of usage. The major advantage is that users only pay for the exact amount of resources used, and resources available can be easily scaled to accommodate rapidly changing needs. Architecture scalability is achieved through Full- or Para-virtualization, such that multiple systems or operating systems can be run at the same time on a virtual machine or across multiple machines;

- **PaaS - Platform as a Service** can also be supplied by the Cloud and allows software and service development without downloading tools and software to client machines. Using the Cloud, large and complicated software packages can be developed, tested and disseminated, again leveraging the benefits of virtualization and scalability (for unforeseen development needs requiring more CPU hours);

- **SaaS - Software as a Service** is one of the most common uses of Cloud Computing, exemplified by Google’s Gmail. Clients access software services such as email, word processing, spreadsheets, etc. from the Cloud instead of running these applications directly on their client computers.

In summary, the salient features of Cloud Computing from a business, computer engineering and by extension educational perspective are maximization of efficiencies (optimization), rapid scalability, and an attractive pay-as-you go arrangement available from many Cloud vendors. Some comparisons have been made with the older mainframe model from the 1960s to 1980s in which IBM, Inc. was a primary player, involving a large capacity centralized host computer and ‘dummy terminals’ which were simply input and readout devices (did not execute functions). However, Voas has alerted us to important distinctions between the mainframe and Cloud Computing models: “Unlike a mainframe, which is a physical machine that offers finite computing power, a cloud represents all possible resources on the Internet, suggesting infinite power and capacity. Meanwhile, unlike a simple terminal acting as a user interface to a mainframe, a PC in the cloud computing paradigm possesses significant power to provide a certain degree of local computing and caching support” [3].

Several private Cloud e-learning systems have been developed and documented. BlueSky Cloud framework at Xi’an Jiaotong University in China enables virtualization of physical machines to be allocated on the fly and “delivers reliable, scalable and cost-efficient services to E-Learning systems” [4]. Also, “The Hochschule Furtwangen University (HFU) is running their own private cloud infrastructure, called Cloud Infrastructure and Application CloudIA. The targeted users of the CloudIA project are HFU staff and students running e-Learning applications, and external people for collaboration purposes” [5].

Major projects are further underway in Japan and Malaysia [6,7]. A Google Docs-like portal running on Amazon Elastic Cloud (EC2) for teaching statistics using R and Scilab software has been successful in teaching mathematics and statistics [8].

### 1.2 Benefits of Cloud Computing to E-learning in MENA

Pricing and overall cost must be cited as one of the most favourable benefits to the MENA region. There is a widespread shortage of qualified ITC professionals, training programs and trained e-learning educational staff in the North Africa region. Recent political upheavals in several North African countries will undoubtedly accelerate brain drain from Egypt, Tunisia, and Libya. Saudi Arabia, Bahrain, and Yemen are further experiencing the rumblings of dissent, which can only have a negative effect in disrupting educational initiatives and society in general. Thus, renting computer platforms and scalable power makes eminent sense, particularly when institutions feel the threat of the potential theft or destruction of computer hardware, such as the widespread looting of schools and offices by Iraqi troops in Kuwait during the first Gulf War. As Grossman points out, “Cloud computing is often offered with a pricing model that lets you pay as you go and for just the services that you need. For example, if you need an additional 1,000 computing instances for an hour, you pay just for these 1,000 computing instances and just for the hour that you use them. No capital expenditure is required” [9]. Price is also mentioned as a positive feature of adopting the Cloud for
learning in Zhang Guoli and Liu Wanjun’s survey of Cloud Computing in the development of platform architecture [10].

Overall, not just hardware costs, but also system management, licensing costs and fees can be reduced as users only pay for the software they need (concept of ‘on-demand’ software). User agreements and contracts can be simplified, with the user only paying for individual software instances and also avoiding the time and cost of patches and updates. As Monfort observes, “SaaS software vendors may host the application on their own web servers or download the application to the consumer device, disabling it after use or after the “on-demand” contract expires. “On-demand” licensing and use alleviates the customer’s burden of equipping a device with every conceivable application. It also reduces traditional End User License Agreement (EULA) software maintenance, ongoing operation patches, and patch support complexity in an organization” [11].

1.3 Privacy Concerns

Miller echoes a often-repeated concern about Cloud Computing privacy limitations: “Providers, users, and the federal government agree almost universally that cybersecurity is the predominant risk” [12]. A survey of 147 educators and end-users working in technology-enhanced learning environments in 17 countries by German and Slovenian researchers demonstrated that the “Majority of the respondents are not satisfied with the current level of data protection and privacy in TEL, and they believe that the related problems will increase in the next 5 years” [13]. Cloud computing may introduce additional security and privacy concerns, although the topic is controversial in this regard. Privacy is closely related to security, and thus far only 2% of European businesses have adopted Infrastructure as a Service (IaaS) according to the analyst company Forrester Research, due to privacy concerns [14].

As Roger Nevin points out: “There is resistance to the use of Google Apps in some educational communities because student and teacher data including all email is located on a server outside the domain of the school district. The main concern is that privacy and security may be compromised” [15]. Cloud security was the subject of a NewsHour Extra report in 2009. Mahanta reported: “A World Privacy Forum report says privacy fears are just the tip of the iceberg. As people and businesses take advantage of Internet-based services, they may well find trade secrets in the hands of competitors, private medical records made public and e-mail correspondence in the hands of government investigators without any prior notice, the report warns” [16].

Pocatilu [17], on the other hand, believes that Cloud Computing can be inherently more secure than current architectures. Although counterintuitive, the Cloud according to Pocatilu provides security benefits: improved improbability, since it is nearly impossible for a thief to locate a virtualized machine, and virtualization allows the rapid replacement of a compromised machine; centralized data storage means that the loss of peripheral devices like laptops, PDAs are not catastrophic for a company; oversight is easier, as personnel do not have to monitor thousands of individual computers.

However, the University of Massachusetts (UMass) introduced Google Apps for primarily email services in 2009 and then discontinued the service in 2010. Although low adoption rates among students was one reason for the cancellation, another reason was that “‘legitimate concerns’ over security” arose as UMass continued to explore the service and shortly before opening Google Apps to undergrads, the University decided not to offer it to faculty or staff as it had originally planned. Because faculty and staff are state employees and at times use e-mail to send confidential information, they must follow state and federal security standards when communicating via electronic or other means” [18]. But Google, disappointed with this decision, has countered that its Postini Services provide adequate internet security to control email addresses, provide filters for inappropriate language and cyberbullying, and encrypt messages.

In addition, “some cloud services reserve intellectual property (IP) rights over everything you post so may lose IP in critical materials or to collections of materials - such as those you compile on Delicious” [19]. This realization could have dire consequences for developers of learning materials in the Arabic-speaking world, and may prevent them from using specific services, but more often than not, they may use a free service not knowing that they are permanently surrendering the rights to the fruits of their labours. This situation in which posters surrender Intellectual Property rights to the service, will undoubtedly soon become the arena of numerous lawsuits when these “free” sites begin capitalizing on their property, which many individuals still believe that they own themselves.
Security concerns are also raised by some Cloud vendor policies of retaining deleted account information: in fact, clients are often lured into free services in exchange for the personal data they contribute to a site as well as their web activity as recorded by cookies or server logs. All of this is valuable information for marketers and laws on how this information can be used and sold are considerably murky in countries such as the U.S. As SMART Communications, a Philippines wireless network provider, warns, “Deleted accounts do not mean deleted contents. Content can be retained forever even if you wish the opposite, and even if it was your content in the first place. This is often specified in the terms and conditions of service” [20].

A recent report on data confidentiality and auditability has appeared from Berkeley University, and it summarizes some of the key issues about Cloud Computing. To quote directly from the report Above the Clouds: A Berkeley View of Cloud Computing: “My sensitive corporate data will never be in the cloud.” Anecdotally we have heard this repeated multiple times. Current cloud offerings are essentially public (rather than private) networks, exposing the system to more attacks. There are also requirements for auditability, in the sense of Sarbanes-Oxley and Health and Human Services Health Insurance Portability and Accountability Act (HIPAA) regulations that must be provided for corporate data to be moved to the cloud. We believe that there are no fundamental obstacles to making a cloud-computing environment as secure as the vast majority of in-house IT environments, and that many of the obstacles can be overcome immediately with well understood technologies such as encrypted storage, Virtual Local Area Networks, and network middleboxes (e.g. firewalls, packet filters). For example, encrypting data before placing it in a Cloud may be even more secure than unencrypted data in a local data center; this approach was successfully used by TC3, a healthcare company with access to sensitive patient records and healthcare claims, when moving their HIPAA-compliant application to AWS” [21].

A specific concern about integrity of data storage has arisen in the Arabian Gulf countries of Saudi Arabia and the United Arab Emirates. Many countries have laws about storing data outside of national borders, on servers which are outside that country’s jurisdiction. The U.S. Patriot Act forces companies in the U.S. to hand over data to the government without a lengthy or carefully scrutinized warrant process and many international companies are therefore concerned about storing sensitive corporate data on U.S.-based Cloud computer servers. Also moves were made recently in India, UAE and Saudi Arabia to ban the RIM Blackberry device, or to locate Blackberry servers where national governments could monitor messages, because Blackberry’s superior mode of encryption allows for secure transmission of information inaccessible to security forces. Educational institutions in MENA may encounter difficulty using Cloud services, therefore, due to government security concerns.

1.4 Reliability Concerns

Reliability will be a great concern for MENA educators and school systems that adopt a Cloud Computing model. Large vendors in U.S. and Europe may be unwilling to devote adequate resources such as technical support, bug fixes, etc. to smaller markets in the Middle East. Current internet infrastructure in the Arabian Gulf and Egypt is particularly vulnerable, as a great deal of international traffic in the region is carried by a small number of undersea cables. The South East Asia-Middle East-West Europe 4 (SEA-ME-WE 4) cable was severed in 2008 causing internet outages in Egypt, India and the Persian Gulf. However, in the response to a lack of regional data centers in the developing world, “providers such as Amazon, Google, IBM, Microsoft, and Sun Microsystems have begun to establish new data centers for hosting Cloud computing applications in various locations around the world to provide redundancy and ensure reliability in case of site failures” [22]. Qatar Cloud Computing Startup has signed an agreement with Vodafone in Doha, Qatar. Also in 2009, The Qatar Cloud Computing Initiative was developed by IBM in conjunction with Carnegie Mellon University in Qatar, Qatar University and Texas A&M University at Qatar.

But many free cloud services that educational institutions are looking at for adoption are in the beta phase or may be run on a non-sustainable financial plan. Millea observes: “Applications in the cloud are provided by commercial entities to make a profit: sometimes they are still in beta, sometimes they are from start-ups funded by venture capital which may run out, sometimes it’s decided they are not viable. That means there’s no guarantee that service you use and rely on today will continue to exist, and your transition time from one service to another may be limited” [23]. An example of a discontinued Cloud service was Google’s 3D service ‘Lively,” a response to Linden Lab’s increasingly
popular online virtual world Second Life. Just as with Second Life, educators began building educational modules on the site, but it abruptly closed in December, 2008 only months after it had been introduced during the summer time.

1.5 Cultural Issues

There are many cultural concerns with using Cloud Computing vendors which have not yet been fully investigated. In addition, there are unresolved problems with e-learning itself in Islamic countries, as surveyed by Weber in 2011 [24]. What if, for example, an external site is supported by advertising with content inappropriate to the Islamic context, such as dating websites? Inappropriate content, especially if accessed by children, has been widely cited by Islamic officials involved in e-learning, e-commerce, and e-government as a major barrier for wider adoption of the internet in the MENA region. The high cost of the internet in MENA also plays a factor in slow adoption, but the perception that content on the internet could undermine or weaken Islamic values is widespread.

1.6 Flexibility, Independent Control of Learning Objects

The introduction of the personal computer (PC) in the 1970s was hailed as a liberation from centralized computer systems (mainframes) controlled by administrators. The development of learning objects and e-learning systems has certainly been facilitated since the mid-1990s by the flexibility and control inherent in controlling one’s own hardware and software, particularly when one thinks of Linux-based or open source products that have recently emerged such as Moodle. Despite the many potential benefits of Cloud Computing in the MENA regions, Jonathan Weber points out that there is a “flip side, though, is that you're dependent on someone else for your technology, and that can limit your flexibility and even your creativity. In fact, the personal computer itself arose because the old model of business computing, in which companies had big mainframes (aka clouds) and everyone connected to them via "dumb" terminals, was enormously frustrating for the people sitting at those dumb terminals. They could only do what they were authorised to do. They were dependent on the computer administrators to give them permission or fix problems. They had no way of staying up on the latest innovations. The personal computer was a rebellion against the tyranny of centralised computing operations – and of the IBM mainframe world in particular” [25]. The increasing ubiquity of Cloud services, in fact, may be somewhat more sinister than proponents of Cloud Computing for e-learning are willing to admit. Weber continues: “over the long run the lack of flexibility inherent in someone else running your tech will become a problem again. You'll be able to get any kind of software or service you like for a very low price – as long as it's a piece of software or service that Google and IBM think is appropriate” [26].

Flexibility and the ability to adapt and redefine learning objects is what is precisely needed in MENA countries: most of the learning objects in the Arabic-speaking world have been developed in the west, and there is a strong need for native language modules. Arabic educators may be reluctant to develop educational materials in Arabic using Software as a service if they feel that the service could change dramatically and no longer meet their needs, or become incompatible with legacy materials.

II. CONCLUSIONS

Clearly, Cloud Computing holds many benefits for MENA region and the Arabic speaking countries in which e-learning systems are coming to maturity. The prospect of outsourcing the time and cost involved in maintaining data centers, platforms and software for delivering e-learning objects will be particularly attractive to countries with constrained education budgets, or for areas with ITC personnel shortages and low PC penetration rates. However, security, reliability, and privacy issues have not been resolved satisfactorily even among the largest currently operating Cloud Computing vendors, and these issues are further compounded by the Arabic and Islamic world context, in which control of personal data is of paramount importance. Individual honor is closely tied to family and tribal honor, particularly in the Arabian Gulf, and the potential for maliciously appropriated data from Cloud systems to cause social disruption is great. Gossip can lead to ostracization, repudiation by the
family, or in the worst cases honor-killings. Similarly, the release of health information, such as HIV status, could lead to severe consequences since homosexuality is strongly condemned in Islam.

References


