Adapting Cloud Computing in Higher Education

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Abstract— In the present era of Information Technology (IT), institutions worldwide becoming highly rely on the IT services such as cloud computing for their knowledge and learning demand and support. Being able to study or teach anytime, anywhere is where we're all headed. It's important for higher education to echo this as well–provide more flexibility for teachers and students. Cloud computing is considered as very stable IT technology that has the high potential of supporting blended learning methodologies in education such as electronic (e) learning and mobile(m) learning.
Cloud computing services are delivered to the end users as a service over a network mainly on the Internet, Computing resources are hardware and/or software that exist in on a remote machine. Cloud computing has high potential to remarkably bring down institutions high investment on hardware, software and IT maintenance as it work on the principle of pay-as-you-go.
The paper explores conceivable outcomes of the cloud computing technology that can help higher institutions to support the process of blended learning. This paper describes about how we can implement cloud computing infrastructure in higher education especially in universities. This paper also try to examine how colleges and universities can take advantage of the benefits which cloud computing technology is bringing, not only economical feasibility, but also in terms of student outcomes , performance, efficiency and the environment by expanding the accessibility of education, especially in remote and underserved areas.

Index Terms— Cloud computing, Higher Education Institutions, Cloud based learning and Blended Learning.

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1 INTRODUCTION

THE right to Education shall not be limited to a college campus, with the rise of cloud computing Technology, immense amounts of knowledge are available in a form of   digital textbooks, mobile connectivity, top class streaming video, etc that makes education as placeless and just-in-time learning domain.

Cloud is a metaphor for describing the internet. Cloud computing is a mean of using the internet for your computing needs. With cloud you can use applications and system software like Plug and Play devices i.e. without downloading and installing it, although these will be billed by consumption (If the cloud is not Public). Cloud computing is fully enabled by virtualization technology (Hypervisors) and virtual appliances [1].

A virtual appliance can be installed, decommissioned and provisioned as needed, without complex configuration of operating environment.

With the expansion of Google-IBM and Yahoo initiative to evolve from traditional computing into cloud Computing, there has been a very positive response from many Universities of the world, who already have begun to shift their infrastructure to Cloud Computing, The reason for this change to Cloud computing as advocated by David Wyid in his article" Cloud Computing 101: Universities are migrating to the cloud for Functionality and Savings" being,

functionality and savings [2]. Cloud computing facilitate students across the globe to acquire the knowledge, skills and training they need to compete and succeed in the global information society.

The world is running on the slogan "Survival for the fittest" and this is true for business as well. With competition there is a future for an organizations and projects.

The same rule if applied to cloud computing, we see a lot of competition going on these days. The biggest software industry giants, Apple and Microsoft, both competing yet again and this time on Cloud computing. Apple being the underdog and is very cautious with a few cloud services available like MobileMe, Iwork.com and itunes. Microsoft Azura on the other hand promise to bring a new beginning to the world of cloud computing.

In contrast the Biggest Hardware Giants Intel and IBM also are in competition with their investments in cloud computing. Taking the same slogan in mind for competition, King AbdulAziz University has also stepped forward to implement the Cloud computing on campus to improve research work and cut down the cost.

The paper is organized as follows: Section I describes Introduction of the paper, sections II discuss Cloud Computing and the number Three concepts and its feature, Section III Cloud Computing and Higher Education, Section IV Identifying Cloud Services, Section V describes Education Cloud Models, Section VI listed risks in Cloud Computing and Section VII conclusion and future work.

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2 CLOUD COMPUTING AND THE NUMBER THREE (3)

Cloud computing can rightly be said as running on the number Three (3). Cloud computing has Three Parts, Three main services, Three main types and except many Cloud Computing providers[5][6].

2.1 The main Cloud Computing Providers are:

- Amazon Elastic Compute Cloud (EC2)
- Google AppEngine
- Microsoft Azure
- Canonical Ubuntu Enterprize Cloud
- Yahoo M45 Computing Cluster
- Google-IBM
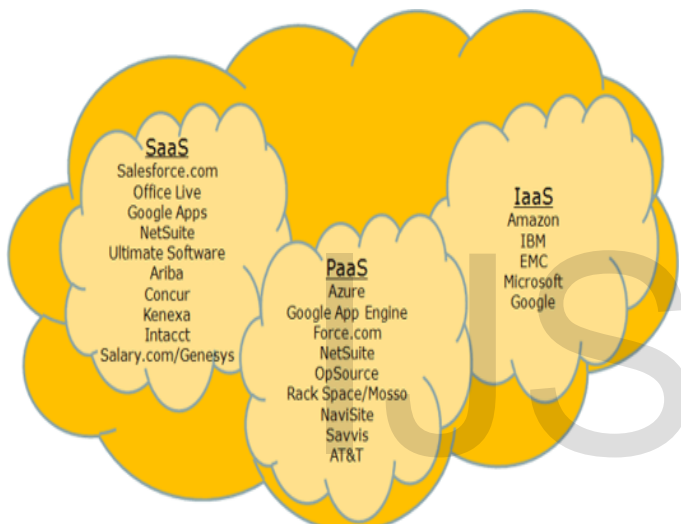
Fig.1. The Cloud Providers

2.2 The three main part of the cloud computing are:

- The most important of the three parts of Cloud computing is the Cloud itself which act as a grid station /power station of services provided to the Client computers on request via browser.
- The second part is Internet through which the services are provided.
- The Third part of Cloud computing is the User of the cloud (Who simply use the cloud).

2.3 The three main services the cloud provides are:

1. SaaS (Software as a service): providing services for application software to many end users. e.g Google Apps and Salesforce etc.
2. PaaS (Platform as a service): Providing development environment as a service on which the customer can build and test his own applications .e.g Ning, BungeeLabs, Ruby, LAMP(Linux, Apache, MySql and PHP) etc.

3. IaaS (Infrastructure as a service): Providing storage and computing capabilities as standardized services over the network.e.g FlexiScale, Amazon,GoGrid and 3 Tera etc.

2.4 The three main types of Cloud computing includes

1. public: in which the services being sold as pre-paid or (Pay as you go) to many customers or organizations.
2. Private: It refers to the clouds not available to public but built for a single customer or enterprise.
3. Hybrid Cloud: this type of cloud combines public and private storage clouds models. Hybrid storage clouds are often useful for archiving and backup functions, allowing local data to be replicated to a public cloud.
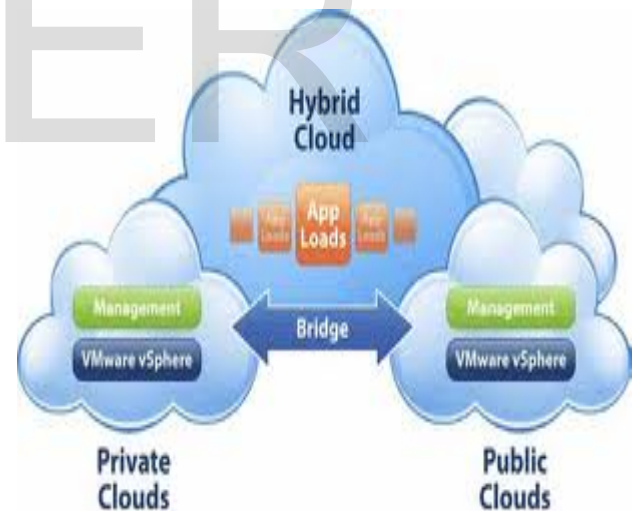

Fig. 2. Private, Public and Hybrid Clouds

3 CLOUD COMPUTING AND HIGHER EDUCATION

There has been much hype about cloud computing, and cloud computing has the potential to play a vital role in education transformations. But first, there remains a need to distill it into a practical, consistent, accessible framework for education.

To understand cloud computing in the context of education, it helps to begin by understanding the notion of "service." A service is a type of software function or capability that is accessible anytime and anywhere via a compute device such as a laptop, desktop, handheld PDA or cell phone [7].

Some of the more common examples of cloud services are Google Apps, Amazon EC2 and SalesForce.com. Other, more generic services include wikis, blogs and e-mail. From a user's perspective, a cloud can make all of these (and more) services available in such a way that the user does not have to be concerned with where the services originate or even where the services are running [8].

The services are just "out there" somewhere, in the cloud, and the user can access them at any time, from any device as shown in Fig. 3. , In reality, cloud services might originate in one place but actually run on a standalone laptop or cell phone, or on a server somewhere in cyberspace.

It's also possible for a single service to be running on some combination of devices. Google Earth, for example, can run standalone on an individual laptop, but when the Earth image on the laptop has to be updated those updates come from one or a combination of Google's data centers around the world[9].
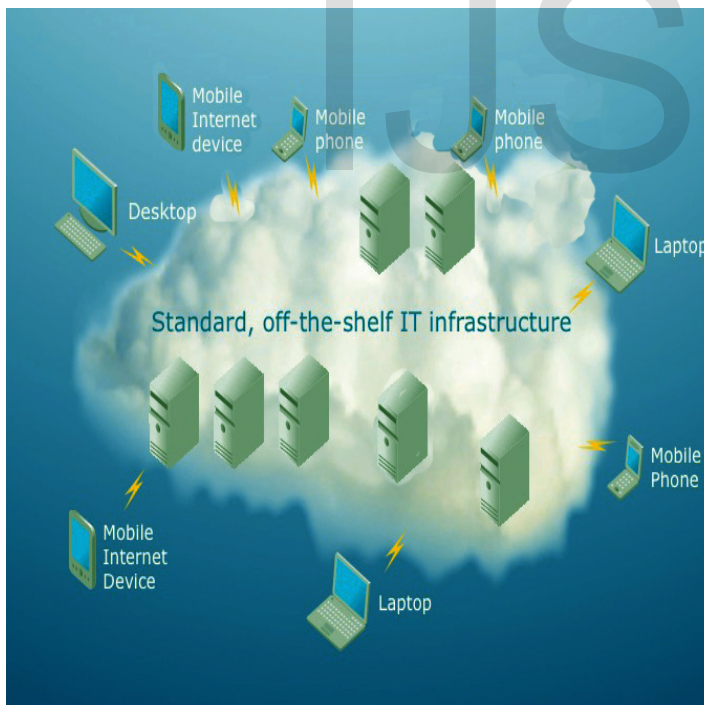

Fig. 3. Cloud computing provides anytime/anywhere services that can be accessed from any device [3].

Colleges and universities are always on the lookout to upgrade their software and IT hardware in order to attract students and keep pace with the rapid developments in digital technologies.

Cloud computing could provide those institutions with the means to achieve those ambitions at prices they can afford. Furthermore, shifting responsibility to external providers for managing some aspects of their software and hardware infrastructures could also result in cost savings with relation to labor, as fewer IT services staff will be needed than before.

To support education transformations, cloud computing can help government leaders and IT decision makers answer key strategic questions such as[10][11][12]:

- What is the quickest, most efficient and affordable way to deliver education?
- How do I develop students' 21st-century skills and prepare students for the new job market?
- How do I encourage local innovation within a country or region?
- How do I share resources across districts, regions or the entire country?

With the flexibility and affordability of cloud computing, it is possible to answer these questions and develop education programs and strategies that also:
- Simplify, speed and reduce the cost of development, integration procurement, and operation and maintenance of ICT
- infrastructure
- Capitalize on worldwide innovation of developers
- Focus on the user experience and expected outcomes, not on infrastructure
- Simplify management of vendors
- Provide better visibility of results and impacts, using cause-and-effect analyses for continuous improvement
- One of the first steps in building a cloud solution is identifying the "layers" of the cloud, which include user services and IT services as shown in Fig. 4.

When you communicate with vendor service providers, these services and their associated parameters need to be defined in a request for proposal (RFP) or similar document.

The "user services" shown in Fig. 4. illustrate a few of the many education specific and generic services the education community can access from devices such as laptops and PDAs.
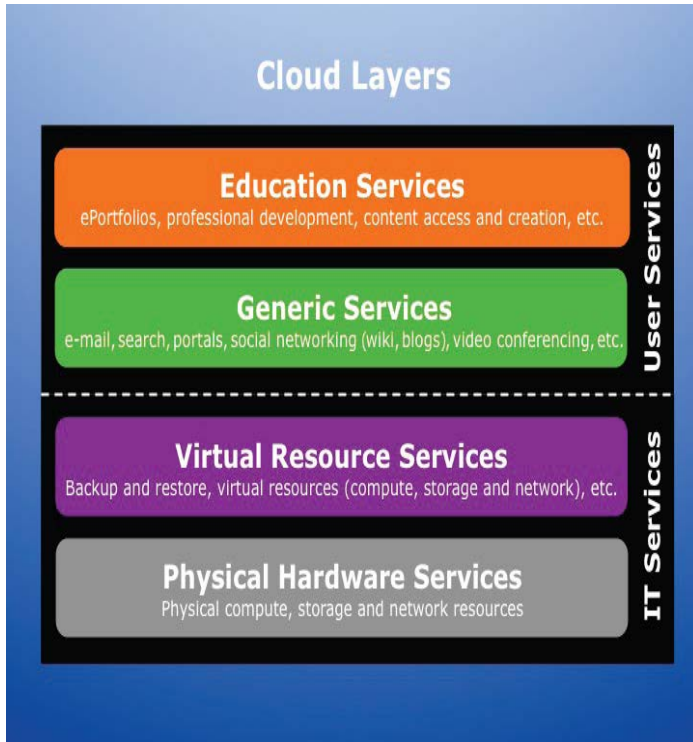
Fig. 4. An education cloud includes both user services and IT services

3.1 Distributing Education as a Service / User Services

An Education services catalog should include education specific user services such as:

- An e-assessment service for managing student assessments
- Grade book, roster, lesson plan and classroom management services for Professors
- Content management services that teachers use to assign curriculum content to students and that students use to access the assigned content.
- An online community service that Professors use to interact with peers and share lesson plans
- A professional development service that Professors use to manage their career development path and become more proficient on the use of technology in the classroom.

The services catalog can also include additional user services that are accessible from the cloud but are not directly related to the delivery of education[13].

These additional services might include:
- A fundraising service to track contribution and fundraising events

- A University asset tracking service to track equipment and supplies
- A University bulletin service to inform parents and the entire community of University activities

User services also include generic services, which often work with and support education services. As shown in Fig. 4, these generic services include e-mail and social networks. For example, an ePortfolio service might employ an e-mail service as the primary interface between the ePortfolio and its users.

A student could then receive assignments from the ePortfolio service via e-mail, and when the assignment is completed, the student could send the completed assignment back via e-mail[13].

Users can also access generic services directly, as when, for example, teachers and students use their e-mail accounts to interact with peers, colleagues, parents and others.

3.2 IT services

Once the user services have been identified, the next question concerns the type of underlying IT infrastructure that needs to be in place to deliver the education and generic services specified in the services catalog.

In Fig. 4, the bottom two layers describe the IT services that define the infrastructure of the education cloud [14][15].

These layers include:

- Physical resources such as client devices, University servers, the University network, Ministry of Higher Education (MoHE) servers, national communication network, storage devices, etc.

- Virtual resources that simplify the management and access of the physical resources by aggregating the physical resources into a collective pool of resources. This aggregation and pooling is commonly referred to as virtualization.

4 IDENTIFYING CLOUD SERVICES

When communicating with vendors, it is necessary to specify the parameters for the cloud services you want and need. These parameters include the following:

• **Function —** This is the function or behavior of the service being specified — what it needs to do, or what capability it needs to have. For example, an ePortfolio service provides an electronic record of a student's academic life.

• **Interface —** This identifies the interface between the service being specified and any other services with which the service interacts. These interface(s) specify input/output behavior in order to characterize the interaction. For example, an ePortfolio service might interact with database services and an assessment service, and perhaps also with a content management service.

• **Authentication, authorization and access (AAA) —** This provides the primary security for the service being specified. For example, an ePortfolio service might permit access to the student for whom a particular ePortfolio exists, the student's teacher, the school's principal and the student's parents.

For each of these people, the access rights and privileges might be different. For example, the teacher can assign a test for a student to take, but would not be allowed to actually take the test. The student may be able to access an assignment from the teacher, but would not be able to change the assignment [16].

• **User interface —** This specifies the interface between a potential user and the service being specified. The interface is often implemented in terms of options and actions that can be selected or performed by a user. Note that there might be multiple user interfaces for a given service.

For example, an ePortfolio service might have a user interface for a teacher to make assignments, another user interface for a student who can use his or her portfolio to access assignments, another for a school principal to monitor the performance of the University, and still another for parents to access their own child's portfolio. For each interface, the behavior may be different and the AAA may be different [17].

When a teacher accesses the ePortfolio service, that teacher may be presented only with specific options and actions, such as issuing assignments or collecting a grade from a test. A student would be presented with an entirely different set of options and actions, such as accessing content assigned by a teacher or taking a test [18].

• **Performance —** This is an essential specification that defines the expected delay or time frame for the service to perform its function. In an ePortfolio service, for example, the MoHE might expect to be able to view a summary of all students' grades within a 48-hour period.

• **Footprint —** The footprint describes how the specified service gets delivered to an end user. For instance, a service could be streamed across the Internet, pre-installed on client devices, or packaged and sent to client devices. In hybrid footprints, such as Google Earth, part of the service resides on a client device and part of it is streamed.

• **Client device awareness —** This is the ability of a service to be aware of the type of device on which it is running or by which it is being accessed.

Depending on the device, the service may behave differently or have different capabilities. For example, the same service may be accessed via a laptop or from a cell phone. The cell phone might be used to inform a student that a project is due the following day, and the student would use his or her laptop to complete the project.

• **Support —** This is the required support expected for the service, and is typically specified in terms of a Service-level Agreement (SLA).

• **Physical location or environment —** This is the physical location in which the service being specified actually runs. For example, a country may not want any of its student ePortfolios to be stored outside the country. Or, part of a student's ePortfolio may exist on the University servers and part may exist on the MoHE's data center servers.

• **Level of connectivity —** This is one of the most important parameters for specification of a service. It defines the level of network or Internet connectivity that is available for the service being specified. There might be absolutely no connectivity (offline), occasional connectivity (offline/online), or always-on connectivity (online).

A common misconception is to equate cloud with the Internet (always online or always connected), but in fact cloud computing can be employed in offline or offline/online environments. The most common level of connectivity specified is an occasionally connected offline/online model [19][20].

This model is often best, even for environments in which the network/Internet quality is extremely high, because it allows for mobile usage. Mobile client devices are sometimes taken to places (airplanes, remote areas, etc.) that lack a network connection [21].

Cloud-based education services should support mobile connectivity so that teachers can always be teaching and students can access learning materials at any time, from any device.

Ideally, services should be able to run at different levels of connectivity, such as across the Internet or a national intranet, as well as from MoHE data center servers, third-party service providers, Universities servers, or standalone teacher and student laptops.

5 EDUCATION CLOUD MODEL

The real power of education clouds becomes evident when viewed from a user's perspective. As depicted in Fig. 5, a set of users (including students, teachers, parents and others) can access a variety of education cloud services, using whatever device or devices they have access to (laptops, desktops, smart phones, PDAs, etc.).
A common cloud infrastructure like the one illustrated in Fig. 5 can scale services across dozens or even thousands of Universities. If an IT infrastructure is already in place, an education cloud facilitates the integration of this existing infrastructure with new technology and solutions[20].

The cloud also "wraps around" the existing infrastructure so that it can be accessed as services. In instances in which there is little or no existing infrastructure, an education cloud helps to make cloud-based services available more quickly to Universities, as well as to teachers and students.
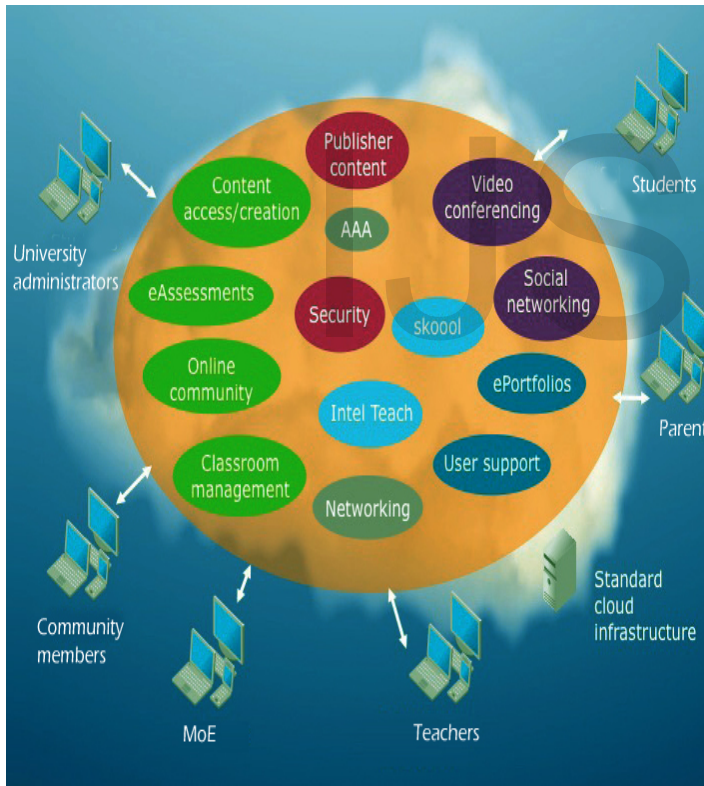

Fig. 5. Education Cloud- User's perspective [3]

5.1 Services Integration

When building a national-scale education cloud or any large-scale IT infrastructure, it is a common practice to employ a system integrator (SI) to integrate all of the pieces of a system. However, Sis can be very expensive and can consume valuable time in defining requirements and designing a custom system that often locks in the use of the SI's own products and consulting services[22].

Cloud computing offers different business dynamics and a new way for systems to be built. This creates a world of new opportunities for services integrators, who are motivated to continually innovate and deliver more and better value-added services instead of relying on consulting services.

The cloud computing model is depicted in Fig. 6 which shows a telecommunications company, or telco, serving as a services integrator for higher-education research[23].
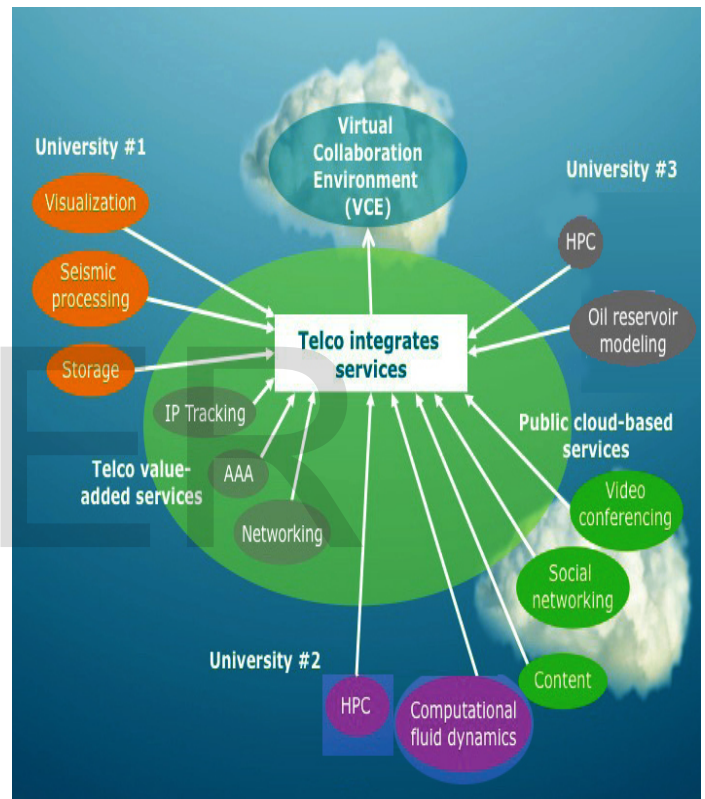

Fig. 6. Higher-education cloud example — provider's perspective

Note that research collaboration is one of the most important functions for universities and is often a challenge because of the need to share intellectual property (IP), as well as the prevalence of resource silos and the difficulty of creating user-friendly collaborative environments.
In the example shown in Fig. 6, three universities are engaging in oil and gas research, and each university has its own IP (in the form of services) that it is making available for the collective research [25]. The telco integrates the IP from the three universities, along with the telco's own value-added services and other cloud services that are publicly available.

The result of the services integration illustrated in Fig. 6 is a virtual collaboration environment (VCE). When viewed from a user's perspective in Fig. 7, this VCE is shown to be a powerful tool that allows researchers to access — at any time, and using any device —a wide range of collected, cloud-based services.

The researchers can focus on their research without concern for where the services originate or where and how they are running.
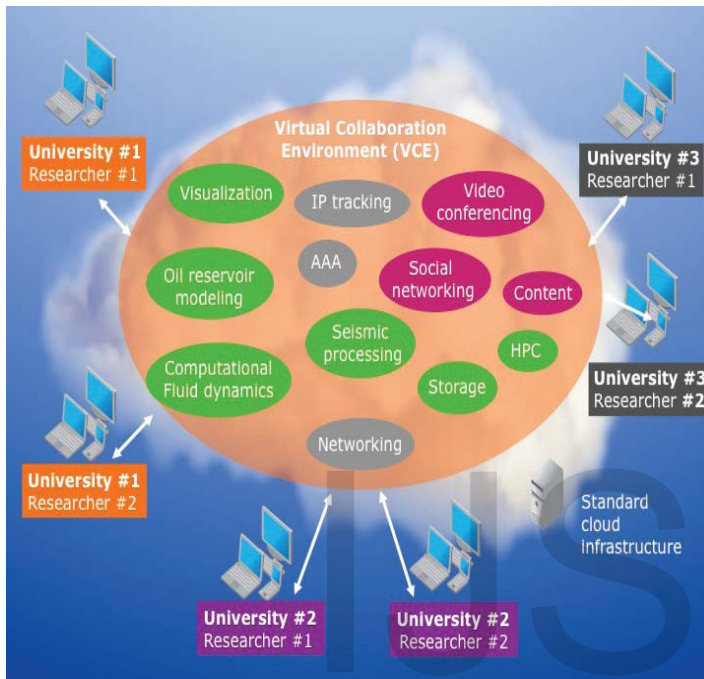

Fig. 7. Higher-education cloud example — User's perspective

7 Risks of Cloud Computing

Cloud computing engage third party control of the University IT system resources, although it provides flexibility   and efficiency in IT services, but also brings number of risk that needs some attention and though. Following are some of the risks and opportunities [24]

Interoperability -- Cloud computing services (hardware as well as software) are generally supplied to client by one supplier, there are chances of having difficulty when client want to move their services from their existing supplier to another supplier.

Fortunately, open standards are helpful in this context, if the cloud computing supplier uses open standards as independent implementations in their cloud service, such as Google's App Engine, moving of services from one supplier to another is possible with little or no efforts [24].

Security -- Internet is the main medium for transporting of data in the cloud computing architecture, Cloud providers uses shared systems to preserved institutions private data, this obviously raises a number of concerns about security of specified cloud computing service [24].

Reliable and robust solutions to the issues exist, but it is upon the level of degree of trust between the institution and the cloud computing service providers.

A number of institutions try cloud computing services with non-critical data first[24].

Reliability: Cloud computing are getting reliable day by day, but still probability of system failure still there but very low. Cloud computing vendors invest in fail-proof systems to provide reliable and consistent services to the clients. Still, a number of well-publicized cases have shown that large platforms can still fail.

Strong Service Level Agreements (SLAs) are proven to be helpful in managing this issue, but not eliminate the issue. It could well be the case that failures become much rarer as the cloud computing approach matures[24].

Legal issues: Datacenters and other resources used in cloud computing are not geographical determined, certain types of data, mainly those concerning students, are prohibited from travelling out of the institution's jurisdiction, resources go to whichever datacenter is available and capable [24].

8 Conclusion

The right to Education shall not be limited to a college campus, Cloud computing is proven to be a leading force in building education system of Nations, It can help communities and nations transform education. An entire world of knowledge is made available to faculty and students through cloud-based services that can be accessed anywhere, anytime, from any device. Digital information that are used in teaching and learning are easily uploaded and accessed.

This paper describe how we can implement cloud computing infrastructure in higher education especially in the University, It was demonstrated in this article how organizations (both small and large) are already taking advantage of the benefits which this technology is bringing, not only in terms of cost but also efficiency and the environment.

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