Cloud Computing Architectural Design Model for Scientific Research and Unified Education System

Sameer Bawaneh
Applied Mathematics and Computer Science, Faculty of Arts and sciences, Eastern Mediterranean University
Sameer.b@outlook.com

Areen Al Khateeb
Applied Mathematics and Computer Science, Faculty of Arts and sciences, Eastern Mediterranean University
khteb1987@live.com

Abstract
Cloud computing is becoming an adoptable technology for many of the organizations including academic institutions with its dynamic scalability and usage of virtualized resources as a service through the Internet. Cloud computing is an excellent alternative for educational institutions technology in order to operate their information systems effectively.

Academic organizations take advantage of cloud based applications offered by service providers and enable their own staff/students to perform business and academic tasks. In this paper, we will review what the cloud computing infrastructure services and deployment models in general and will provide the benefits of cloud computing in the educational field, especially in the universities where the use of computers are more intensive and what can be done to increase the benefits of common applications for students and teachers. The main important part of this research is the proposed solution based on cloud computing with all suggested services and deployments model with highlighting the main features and characteristics of the model to be a unified since research and educational model.

Suggested application, payment, security and privacy model will be discussed at the last part, and ended this research by reasonable conclusion

Main Contribution
The purpose of this research is to suggest a cloud computing architectural design for science research and unified educational system based on the new technology in IT and business intelligence. There are three items on which this research is focused: first part is the academic staff science research and academic system to support all the students, teachers, researcher, academic staff to find all the required application, process and data related to scientific research and academic information in one place, by connecting all the educational field information, users, data source together to be able to gain many benefits for all, like information sharing, easy to access from anywhere, easy to find information, more collaboration, cheap, and many other benefits will be discussed later in this research, the second main part is to have all the required academic and business application for all academic organization in one place on cloud computing like ERP, HR, Finance, … etc which will offer many benefits to academics institutions, such cost reduction, reduce risk, availability, more security, and many other benefits, last part will be focus on integrate all the application together like academic, research, business, key performance indicator and business intelligence application, to be able to control, support and monitor all from one place. Which will make life easy for all users, especially

decision makers, as they can see the full picture from one place and get all the reports and data analysis.

Introduction

The main idea of computer clouding is to use all the latest needed available technology resources such like internet, network, hardware and software integrate all together to create a new technology by creating a huge data centers which can be able to provide a lot of remotely services by using the internet for communication and transport to be provided to customers as shared services with more feature and factors which make it easy than before to end user where end user can have his own services applications in one place, can access any time and from anywhere any place with a lot of facilities where he can pay as per his use for both site functionality and scalability with more and more powerful benefits, so the Cloud Computing is one of the computing models, where it is a huge pool of application and systems connected in multiple ways, to provide dynamic infrastructure for application, data and it can be used also for file storage.

Cloud computing is a distributed computing paradigm that enables access to virtualized resources including computers, networks, storage, development platforms or applications (Mell & Grance, 2009).

Using cloud computing for research, learning and educational environment based on the latest technology models, which provides a unified research and educational system for all the world academic purposes. It satisfies the research and education needs with different educational styles such as research center, student information system, library system, …, etc to be able to reach to the highest level of information sharing, access, globalized, cost reduction and many other benefits for all participants. In addition, it provides mass storage, large-scale computing, quality online services, high-density access, all systems integration, real-time video broadcasting, interactive online classroom and other learning support service system possible.

Along with the continuous progress of human science and technology, learning mode has changed largely from the traditional teacher-student mode to modern science and technology mode, depending on the information technology, such as electronic learning (e-learning), mobile learning (m-learning), etc. These new words mainly emerge out relying on the advent of the Internet online courses.

By definition Unified Scientific Research & Education Center (USREC) is a suggested model for Scientific Research and Unified Education System based on cloud computing technology in network operation mode to provide service and integration between all the academic, researches, business application for all users on the internet. This representative one is named USREC. Which is an advanced research and educational model, with large scale participants, and used for private and public based on high privacy and security system.

The main target of USREC is to have a massive learning resources, large-scale distributed academic and research partner, distributed network research and educational support service, self-organization based on social characteristics.

The organization of USREC network is to create technology enhanced educational network based on social characteristics which is constituted for academic organizations, research institutions and individuals users (student, researcher),

Review Methodology

The literature search covered contributions until and including June 2017, and was performed using the databases considered most relevant to find the targeted studies: IEEE Xplore Digital Library, ACM Digital Library, ScienceDirect, Scopus, Elsevier and Springer. The search string used was: ("cloud computing" or "cloud computing services and deployment models") and ("online education system" or "online academic research model" or "unified educational system"). This search string was conceived with the aim of retrieving a high number of the studies available in the databases that were relevant for the review even if the results of the query returned many other works not relevant for the survey.

Only primary studies published in English and contained in journals, conference proceedings, books and white papers were considered. A total of 131 candidate articles resulted from the initial search.

Each candidate study went through a series of stages until its eventual selection: 1) assess the title, and discard if not related to cloud computing in research and education; 2) read the abstract, exclude if unrelated to cloud computing in education; 3) retrieve the study and read the introduction and conclusions, discard if the contribution is similar to other more relevant study by the authors; and 4) critically assess the quality of the contribution, discard in case of low quality.

The quality parameters taken into account were the degree of relation of the study with the use of cloud computing in the educational domain, the relevance of the contribution for the educational domain, as well as the credibility, soundness, clarity, research methodology, and writing quality of the contributions. After this phase, 54 studies passed the quality assessment.

A data extraction process was then conducted to collect the following information from each contribution: summary and main results, research questions posed, applicable educational areas and contexts, benefited educational roles, learning scenarios envisioned, maturity of the research, reported affordances and benefits of cloud computing, cloud deployment models used, cloud platforms and applications described, and related bibliography. From this data extraction process, a new set of candidate studies for the review emerged from the analyzed bibliography. This set of new studies followed a new iteration of quality assessment. There were 32 additional studies that passed the second quality assessment and went through another data extraction process.

Finally, a qualitative analysis of the results was performed to synthesize the main findings. Since the objective of this study is to identify benefits, risks, and research challenges, the categorization performed in the qualitative synthesis follows this same structure.

The approach followed was bottom-up, considering the salient characteristics and scenarios of these studies and defining and categorizing them into areas.

Cloud Computing

We can consider Cloud Computing is a global term used to describe a new technology of network and new way to get more benefits by using the internet by making all your applications and files easy to access, available anywhere any time by using the large evolution in all hardware internet and other technologies, to provide to customer a lot of the new futures and benefits as most of the new technologies try to make things going faster, easier more sufficient , the new cloud technology guide to dramatically decrease the cost of the services with more feature and benefits will be discussed later in the Cloud computing Characteristics section

There is a many definition has been released for the cloud computing over the internet during the last few years and herein is the latest definition for cloud computing as released by National Institute of Standards and Technology's (NIST), this is the final version which is version 16.

Cloud computing is a relatively new business model in the computing world. According to the official NIST definition, "cloud computing is a model for enabling ubiquitous, 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." 1

Cloud Computing Architecture

Cloud computing system architecture separated into two main parts, Front-End which is students, teachers, researchers, academic and business staff include all the end user access devices such as computers, smart mobile phones, ..., etc along with the required applications need to access the system. The second part is Back-End, which is usually the services provider services, platform and infrastructure site which will include Software, Servers, storage, database, ..., etc.

both front and back end connected to each other through network which is Internet usually a set of roles which called protocol using a special type of software called middleware which controlling the network computer communications and allow all devices in the network to communicate with each other's, this protocols allow the central server administer the cloud system by controlling and monitoring the end users traffic demands to make sure that everything run in the right way.

The application of engineering controls cloud is called cloud-engineering. This is brings a systematic approach for high level marketing concern, standardization, and governance in the conception, development, operation and maintenance of cloud computing systems. It is a multi-disciplinary approach includes contributions from a variety of fields such as systems and software, and the Internet, and performance, information, security, and platform, risk, high-quality and engineering.

All the cloud services providers making copies of client data as backup and store it in another store devices to allow the server to have access to the backup to retrieve the client data this process called redundancy, this is costing the cloud providers double the actual needed storage to keep the client data, but this will enhance the data availability and disaster recovery.

Cloud providers usually maximizing the productivity of individual servers, this will decrease the needs to have more servers this called servers virtualization.

Cloud computing can be classified into Three major services Models as below:

1. Infrastructure as a Service (IaaS): in this module the cloud providers will offer to end users the essential requirements infrastructure which is servers, operating systems, storage and network and these services will be on-demand service. These services will allow the client to save more time and money and instead of buying servers, software, datacenter preparation and network equipment, end user will get a fully outsourced service on demand, moreover IaaS can offer a public or private infrastructure or a combination of the two.
2. Platform as a Service (PaaS): In this services module the cloud vendor provide to client the required platform which is usually include the Hardware, Software, data base, programming language and web servers to allow the client to design and develop the applications which mean that provide development environment to end users along with the tools and standards, testing tools to be able to execute their application in virtual environment without any complexity and save the platform layer cost which usually include the upfront payment, maintenance, operation and support and manpower fees.
3. Software as a Service (SaaS): In the software as a service (SaaS) model, will offer the users the ability to access a huge number of end users ready application, databases and other software and. Whereas, the Cloud computing providers will be responsible to offer the infrastructure and platforms needed to run the application and control it. SaaS we can refer to SaaS as "on-demand software" and regarding the cost of this services, it is normally priced based on pay per use model in or payment could be a subscribe payment.

A cloud offers two different types of hosting as below:

1. On Premise: the applications will be hosted internally in the same organization and the organization team will be taking care of operation and in this case organization will be incurring the cost of the operation. So this will be good option for environments where they need a full control and configuration for the security and infrastructure, like PaaS and IaaS.
2. Externally Hosted: the cloud will be hosted on the outside not within the same organization as private cloud dedicated for this organization but this kind of cloud will be hosted by a third party specializing in the cloud area, moreover service provider will guarantee full privacy, like SaaS. An Info-Tech study show that 76% of IT head will focus exclusively on this cloud, because it is offering the highest level of control and data security.

Cloud computing have four different deployment models; below is more details about all the models.

1. Private Model: This type of cloud is cloud infrastructure design for one company or organization and it will be dedicated to this organization and it will never be shared with any other organizations, so this will allow this particular organization to host their application in the cloud. This kind of cloud will allow organizations to host more applications in the cloud, and in the same time this organization will be taking care of the security and the control, and this services it could be managed by the organization staff themselves or by any other third party, moreover it could be hosted inside the organization or outside.
2. Public Model: In Public clouds the cloud services provider will offer services over the internet for general public organizations which will have access to provided services operated by the services providers with limit control and security protection and all the customers will be sharing the same pool of infrastructure. This kind of cloud is offering very low price to clients because of sharing the infrastructure, as the costs of infrastructure are spread across all clients.

3. Community Model: this model designed for a targeted group of organization which they have the same requirements and goals to work together to achieve the business needs like group of universities, so this cloud is built as a mix of private clouds with special operated specifically, and the cloud infrastructure will be shared between this organizations and it managed by all the organizations or any other party. This could add more benefits to each organization by using the public cloud with higher level of security, privacy almost in the same level of private cloud.
4. Hybrid Model: this model allows the customer to choose any of the previous cloud minimum of two and bound together to get the advantages of multiple cloud deployment models. Moreover, it could be selected from more than one cloud services providers this will for sure increasing the flexibility of cloud computing services, moreover client can select the right cloud for each application.

Uses of Cloud in Education

Some academic institutions use low-level cloud services for data storage but the use of cloud computing in education offers a number of benefits such as economy of financial resources (to pay only what is used), elasticity of use, given the possibility of using initial the small services, increased availability, end-user satisfaction because the applications that can be accessed in the cloud include the latest tools and features from innovative companies, so the users can use, install and maintain the applications on their computers; which will enhanced collaboration possibilities; moreover, data do not get lost, as it is stored in the cloud for use and accessible from any location or from a range of devices such as mobile phone.

Another use of cloud computing in education is for hosting learning management systems (LMS), enterprise resource planning system (ERP), and many other systems which could be pure educational, business, finance and any other online services.

Nowadays the online education system is widely used to different levels of education: lifelong learning, training, academic courses, online student services, academic services, business services, …, etc. Since there are at least two entities involved in the USREC system: students and trainers, the students can access courses, exams and can send online projects while trainers can accomplish content management, tests and can evaluate these tests, homework or projects for students and can communicate with them.

Literature presents e-learning architecture based on the cloud which is mainly divided into five levels called (Kumar and Chelikani, 2011):

- The hardware resources level : the lowest layer of cloud middleware service and most importantly for the total system infrastructure;
- The level of software resources: created by using operating systems and middleware technology, it enables software developers to realize more applications including the incorporating of e-learning applications in the cloud;
- Resource management level: with an important role in poor coupling of hardware and software resources what enable a constant on demand software distribution for various hardware resources;
- The services level (IaaS, PaaS, SaaS), which allows customers use of different cloud resources such as software resources, hardware resources and infrastructure resources to achieve their applications;
- The business application level, that enables creation and content delivery, the platform for education, assessment and management education; this level differs from all other layers in the e-learning cloud-based architecture because it acts as business logic of e-learning and framework for extending components group for e-learning.

According to Masud and Huang in (Masud and Huang, 2011) development of e-learning in cloud computing environment is characterized by the fact that:

- The services are accessed through the Web, which means ease of them accessing from anywhere and at any time;
- doesn't require software on client-side, which means lower costs to the institution concerning the installation, software maintenance, implementing server administration including IT staff costs;
- subscription pay for use, according to the model of education, provides access to complex applications;
- SaaS system can support several educational institutions;
- all user data are on the SaaS server and security is provided by the SaaS provider;
- the virtualization enables rapid replacement of a compromised server cloud without major costs or damages because it is easy to create a clone of a virtual machine so the idle times are reduced substantially;
- centralized data storage and fast possibility to connect a new customer;
- the monitoring of data access becomes easier, given that only one place it should be supervised, not thousands of computers spread over a large geographical area; security changes can be easily tested and implemented as cloud represents a single point of entry for all customers (Wheeler and Waggener, 2009)

Advantages of Using USREC in the Cloud

Decision making USREC implementation in cloud provides many benefits for the educational institutions dealing with this solution due to the following:

- The institutions cut the costs using the cloud applications on the computers, mobile phones, PC tablets, with the least configuration and Internet connection; equipment's are not necessary and the payment is effected only for the necessary applications and for the data stocks.
- The performances are improved as the e-learning applications on cloud have most of the processes and applications in the cloud and the users' systems have no problem regarding the performance.
- The software updates are accomplished on the spot and the users get the updates very quickly.
- The document frameworks compatibility is improved as the e-learning applications based on cloud open the cloud files.
- The cloud- based e-learning grant a lot of benefits for the students mainly concerning the online courses access, the exams and the online communication with the professors.
- The benefits for the professors concern the student's training for the online tests, the creation of more complete resources for the students through the management of contents, assessment and communication with the students using the online forums.
- In the e-learning cloud business model the supplier is responsible for the e-learning cloud organization and maintenance, providing technical support for e-learning cloud.

Presently, the cloud computing platform characteristics are suitable for the cloud-based education as a research and education system because it enables the exploitation of the possibilities provided by the organization of an efficient educational environment which offers a personalized content and its easy adjustment to the current education pattern.

USREC Model Benefits & Characteristics

As has been mention above, there is a lot of features and benefits for using cloud computing in research and education, this research categorized this benefits for students, institutions and common benefits, as below:

Academic organization benefits:

- On-demand capabilities: USREC pay a lot of attentions to make sure that services is available all the time and the users can access it from anywhere as it is available on services application and since the organization will have full access to the selected services with full authority and capability to change his own data and services by modify, update, add, remove,…, etc through an online control panel, by controlling the setting as it is in-house services.
- Elasticity and Scalability: USREC will allow the organization to have full scale usage based on the actual need by increased or decreased the usage based on the real requirements so this give organizations the required flexibility and scalability to choose the right business needs even after the starting.
- Measured service: one of the main model feature is pay as much as you use this mean that institute pay only for the exact amount of usage. Educational institute can easily measure a lot of factors which determine the price of the provided service such as number of user account accessing the services, storage levels, processing and bandwidth. All this information can be monitored by both organization and cloud provider.
- Reduce cost of IT: as the services will be outsourcing to the cloud provider so this will be cheaper for the educational institutions than have it in-house due to the high upfront and maintenance cost to create and maintain the IT infrastructure for any organization, so a lot of cost will be reduced by reducing a lot of IT expanses like maintenance, software, hardware, manpower, backup and recovery, operation services and support.
- Sharing: Skills, good practices, applications, teaching content and infrastructures can be pooled and shared to avoid each establishment duplicating resources that exist elsewhere. Sharing equipment also has the effect of harmonizing resources, making it easier to support them, and avoiding the problems of incompatibility or difficult integration between various tools and systems.
- Effectiveness: The method of deployment USREC makes possible for IT resources to promote more dynamic exchanges and participation between teachers, pupils and students, their social network and parents. The methods available are more numerous and can lead to more productive and effective learning for the student.
- Business continuity and disaster recovery: USREC offer more reliability for disaster recovery and business continuity. By using multiple redundant sites.
- Security: USREC pay a lot of attention and more focus on the security part, as it is critical concern to the end users so the security will be in the same level or even higher level than the in-house system. As Cloud computing vendors are able to provide more resources and consultants to monitor, support and solving security issues than individual client, especially small and medium client organizations.
- Dash board management: USREC make it easy for managements to get reports and see the full picture from one place, where they can get online reports for all registered services, which will make it more practical to have the right decisions based on simultaneous reports.
- Integration: USREC will make integration for all the selected services and connected to each other's, and even can go further to connect it to BI and KPI, to work all together to create a full integrated system including all academic, research, business, marketing, library, admission, …, etc systems.

This is the main benefits to institutions, and there are many others which will be discussed in another research in details.

User's benefits

Users is the end user either he is student, academic staff, business staff, guest, researcher or any other type of users, they will be able to gain at least the below benefits of USREC.

- On-demand self-service and capabilities: as USREC services is a web-based self-service application portal, so this will allow users to connect the resources anytime from anywhere or any place, as all the services and data will be available 24 x 7.
- Cheap for individual users subscribes instead of having many subscriptions with many journals and libraries, and most of the academic institutions users will be given a free access by their academic institute as per the registered services.
- All in one services solution: all participates can get all the information from one place, like grads, financial, registration, library, research, training opportunity, scholarships, …, etc.
- Notification center: users can select to have a notifications by emails or instant messages for their interested topics, services, …, etc.
- One account to manage all: USREC is offering account for every user, and this account could be officially created by institutions for their users, or could be created by individual users by using email or phone number.
- Link to social media: USREC will allow users to link their account to social media accounts like Facebook, Instagram, …, etc.
- Have a wide range information sources like ebooks, notebook, class material, and broadcasting, from multi institutions and libraries over the world.
- Easy and fast communication between all users: USREC is offering a communication and forms for all users, based on their interesting to participate or not, which could be in the form of chat rooms, instant messages, email and messenger.

Common benefits for users and institutions

- Mobility and wide network access: as one of the main cloud services feature that students and employees can access easily through multiple ways and devices, as users can access USREC services by using any kind of devices and operating system connected to internet either it is smart phones, tablets, laptops, or personal computers. So mobility feature is more attractive for organizations so that make the employees available all the time and have access to the services source during business hours or off-times, weekdays or weekend days either they are traveling or at office all the same for USREC services.
- collaboration: USREC services available over internet allows many lecturers, researchers and students from the same educational organization to work together and share data within in the same time and from any place, again this is another great benefits specially organizations who has more than one branch or multiple branches in different cities or countries or any one working outside the office to work together.

USREC Proposed Model

At the beginning all participated academic institutions, research organization should be ready to connect to USREC, and the connection requirements depends on the selected services and type of deployment model, as some of the deployment models need a high infrastructure to be ready like the main parts of compute resources (processors, memory, storage, network, etc.), moreover this organizations should offer access devices to their staff to be able to connect to USREC through cloud services by having appropriate network design. Individual users should also perform all the necessary devices to connect to cloud like desktop, mobile, tablet and to be connected to internet.

USREC Goals

One of the main goals for USREC design is to meet the needs and expectations of all users and staff (student, teachers, researcher, finance and accounting, purchasing and procurement, IT administrators, …, etc.), moreover, to meet the challenges and new technology for all related field like education, training and research needs for all the users.

USREC is paying attention to the availability and scalability as one of the crucial goals of the system, as this feature inherited from the cloud computing, moreover user friendly interfaces of USREC applications enable users successfully enlarge their computing environment. USREC content (scientific materials, research, opinions, textbooks, etc.) is controlled by the USREC service providers and available to users whenever they request, to be as reference to all educational contents in one place.

Improved data mining techniques filter and find the requested content in order to help students. Student's objectives are not limited to their courses or university, hence existing content should be changed dynamically and frequently.

Cloud computing metaphor

The proposed USREC model will be based on SaaS cloud computing delivery services, as it have a quickly market growth as almost double growth in the last few years. This fast and huge growth may show that SaaS will be soon having a wide use inside each educational organization.

SaaS is nowadays the best-known model, consisting of applications offered by the provider over the network, instead of being run on the user's computer. Resources found at this level range from actual applications to multimedia or web services, and are usually accessed via a web client (Zhang et al., 2010).

Herein list of the most Characteristics of USREC, which is the main important for organizations from the IT administration point of view, in additional to the benefits of cloud computing mentioned above, Integration between different pieces of software by (APIs) Application Programming Interfaces.

- No efforts needs from client to manage the software upgrade and patches.
- The software delivered in a one-to-many model
- End users can manage software from a centralized place.

USREC deployment model will be based on hybrid environment, as Hybrid is the best deployment options which care about the main educational institutions concerns, which is the security issue and data importance especially when academic institutions providing a services to different type of business and to make sure that all their data is protected and secure.

Hybrid SAAS Architectural Design

Hybrid SaaS combines SaaS solutions with an on-premise software application to provide the benefits of SaaS with more security and user control. The functional aspect of the USREC is presented through the cloud, hosted by the cloud provider. A user logs into the application from a web browser or application and accesses a USREC cloud-hosted environment including the user interface, functionality, and mechanism that managing files. The users' data, however, is stored in whatever environment they choose until it is encrypted and transferred over the Internet.

With hybrid SaaS USREC solution, users can store data on an on-premise server that is managed by the academic organization or on the cloud. This will offer to user to have more control over where to keep the storage. Security concerns are eliminated without sacrificing the benefit of USREC.

USREC hybrid SaaS is scalable, flexible, reliable and low cost so all users from all field can have easy access with top-notch security.

The traditional Hybrid SaaS model is where the users may deploy the software as a SaaS service or as on-premises solution, with the ability to switch from one to the other as needed. This model has arisen in response to the drawbacks of the pure SaaS model and is claimed by proponents to provide the advantages of the SaaS model, while mitigating the potential drawbacks. There are corresponding arguments against this model. For example, the software provider must design the product to support both in-house installation and its use as a hosted service.

The 'HomeBrew' Hybrid SaaS model, where a client uses functionality from both the cloud via SaaS, combined with a more traditional solution on-premises. Both solutions are operational at the same time, unlike the traditional hybrid SaaS model detailed above. This kind of model would most typically be used for content security solutions with transient data already on the 'public' internet, such as email traffic. The chief benefit of this type of solution is that a high percentage of content can be removed before they reach the premises of the customer, reducing hardware and bandwidth requirements. The main disadvantages are that two disparate solutions are in use, which means two management consoles to monitor and configure the solutions, as well as two sets of licence/subscription costs.

The Next Generation of Hybrid SaaS solutions are just becoming available. They extend the HomeBrew hybrid SaaS model to include interoperating solutions situated both on the customer's premises, as well as located within the cloud, therefore building on the strengths of the homebrew model and removing many of the drawbacks.

Typically, the cloud component is located within a managed datacenter operated by a service provider, who would often also be the vendor of the on-premises solution. As per the USREC design which will be based on HomeBrew hybrid SaaS model, both solutions are operational at the same time. However, the main difference is that the solutions are not disparate; links exist between the on-premises solution and the cloud platform in order to mitigate the drawbacks of the Homebrew Hybrid solution.

Hybrid SAAS Solution for USREC

Three key value points of hybrid SaaS cloud computing to be consider for USREC as below:

- Enables a highly cost-effective, rapidly responsive and elastic IT, better aligned with the business needs in order to support two speed IT. A hybrid cloud can be designed for dynamic consumption, interconnection, orchestration and control of all types of cloud services. Hybrid cloud enables a more responsive and elastic IT that is able to quickly respond to the demands and needs of both steady speed systems of record (SoR) and new fast speed systems of engagement (SoE). Workloads are enabled through automation and programmable IT through open infrastructure APIs and compostable infrastructure services.

- Provides a portfolio of business and IT services that leverage the best capabilities of cloud service providers, enabling flexibility in what can be built and where it can be deployed. Using cloud services provides new tools and data for innovation. The business is no longer constrained by what they have available on-premises. In essence, the "catalog of services" that they have at their disposal increases dramatically.

- Enables the business to innovate faster while leveraging existing systems and capabilities. Simply put it comes down to time and money. The ability to compose

services from both on-premises and off-premises (i.e., hybrid) is a key enabler to increase speed to market and to reduce costs.

DEPLOYMENT of USREC System

Here are the four basic options for application placement provided by USREC hybrid SaaS cloud environment:

1. Place the application and its datasets into a public cloud environment connecting to existing enterprise applications and datasets on-premises as required.
2. Place the application and its datasets into a private cloud environment connecting to existing enterprise applications and datasets on-premises as required.
3. Place the application on-premises (or into a private cloud environment) and link to public cloud services as required to obtain new or specialized capabilities.
4. Place some components of the application and its datasets into a public cloud environment while placing other components into a private cloud service and/or an on-premises non-cloud environment, linking them together as required.

Deployment decisions must consider these four options. IT architects should assess the right application architecture to achieve maximum benefit. The deployment option selecting mainly depend on the customers design and the importance of the data as well, this includes understanding application workload characteristics and determining the deployment model for multi-tier applications. For example, understanding where heavy processing is performed and the interaction between presentation, business logic, integration, and data layers is key to making the right application deployment decisions. This has to be understood to ensure acceptable application response times are maintained in the hybrid model.

Cloud Services Brokerage (CSB)

According to the NIST definition [1], a cloud broker is ‘‘an entity that manages the use, performance, and delivery of cloud services, and negotiates relationships between cloud providers and cloud consumers’’. A similar definition is given by Gartner. That envisions a broker capable of performing automatic resource provisioning and management, as well as automatic deployment across multiple clouds.

Due to many providers that exist in the Cloud (storage, computing, or other services), as well as the different architectures designed and many multinational academic institution with different applications models, will be part of USREC, so for this purpose many risks arise. Vendor lock-in because of the different APIs used by the Cloud Services Providers (CSPs), the acquisition of services from different providers requiring coordination, ensuring a higher level degree of security of data and information in USREC and the adoption of different architectures. To address all these problems, the Cloud Service Broker will be the integration engine of USREC, serving as an intermediary between the firm and the Cloud Services it has acquisitioned.

Cloud service brokerage is emerging as an important component in for delivering consistent and accurate placement and prioritization planning for applications in USREC. Cloud service brokers function as intermediaries between USREC and enterprises and help strengthen the relationships providers have with customers by offering planning, integration and management services. They provide tools to govern and control environments across private and public clouds covering cloud spend, security and resiliency aspects from the application infrastructure design through the final cloud managed services that are actually provisioned and utilized.

While the main USREC technical services for CSB will be defined as:

1. Service Intermediation: A CSB enhances an existing service to add value to it.
2. Service Aggregation: A CSB integrates multiple Cloud services into one or more new services.

3. Service Arbitrage: A CSB can dynamically replace components of an aggregated service.

How USREC System Work

With a USREC solution, a user can access the functions of the software from the cloud. They log into an application from their web browser of choice and then user several aspects of the solution in the cloud. However, their data is stored offline before being encrypted and then transferred using the internet.

Data storage in a USREC scenario can be completed via an on-site server managed by the business, or via the cloud which is managed by the application host. This provides the user with far more control over where their data is stored. As well, users can enjoy security without having to sacrifice the convenience of the cloud.

USREC Application Model

The proposed USREC System is more than erp, crm, business intelligence system for Higher Education Institutions and Universities it is fully powerful integrated system trying to achieve all the goals of academic, business, education, eLearning, library, social education network, research in effective and intelligence way. Implementation of USREC results in significant improvement in all aspects of University / College performance parameters namely student administration (enrollment, fee, staff, entrance examination etc.), academic management (time table, academic calendar examination etc.), student services, compliances etc. With its inbuilt security and audit features the system can self-check any rule violations and bungling's in areas like fee collection, examination etc. All the stakeholders of the University / Higher education system namely Board of Directors, University Administration (Vice Chancellor, Dean, Registrar etc.), Students, Parents, Staff and Departments are immediately benefitted due to transparent availability of information and services.

USREC application model will contain mainly 7 application model, each model will be directed to manage one of the main goals of the system, below is the summary details for each model.

Academic Organization Resource Planning (AORP): is made up of many software modules. Each AORP software module manage and maintain a major functional area of an academic organization. The basic AORP provided services listed in table (1).

Table (1) Academic Organization Resource Planning module provided services

Number	Models
1.	Planning
2.	Supply change management
3.	Project management
4.	Finance and Accounting
5.	Support
6.	Tracking
7.	CRM
8.	Human resource HR
9.	Sales
10.	Marketing
11.	Inventory control
12.	Business Intelligence system.
13.	Key performance indicator

Student Information System (SIS)

The majority of SIS took the opportunity to design new features for not only classrooms and housing, but automating or simplifying processes in relation to a student's lifecycle. From application and Financial Aid, to career services and online education, below some of the major services will be provided by this modules:

Table (2) Student Information System module provided services

Number	Models
1.	Maintenance and reporting of student data
2.	Handling inquiries from prospective students
3.	Enabling online scheduling
4.	Automatically creating class and teacher schedules
5.	Handling records of examinations, assessments, marks, grades and academic progression
6.	Maintaining records of absences and attendance
7.	Recording communications with students
8.	Special Education / Individual Education Plan (IEP) services
9.	Student Announcements, scholarships, vacancies.
10.	Accounting and budgeting services
11.	Canteen Management
12.	Fees Management
13.	Regulatory reporting and reports for accrediting bodies
14.	Handling the admissions process
15.	Enrolling new students
16.	Student accounts and financial aid processing
17.	Maintaining discipline records
18.	Providing statistical reports
19.	Capabilities to operate multiple campuses, online and on-ground, in multiple countries and languages
20.	Housing, dorms and facilities details.
21.	Communicating student details to parents or other persons authorized by the student, through a portal
22.	Career services management for student portfolios and matching with potential employers
23.	Training and workshops.
24.	Student health records
25.	Transportation Management
26.	Inventory and Assets of the school
27.	Assignments and tasks management.

Digital Library (DL)

Is a special library with a collection of digital objects that can include text, visual material, audio material, video material, stored as electronic media formats. Digital libraries can vary immensely in size and scope, and can be maintained by individual user's, research organization, or affiliated with established physical library buildings or institutions, or with academic institutions. The digital content will be stored by USREC. An electronic library is a type of information retrieval system.

Table (3) Digital Library (DL)module provided services

Number	Models
1.	E-book
2.	Audio
3.	Video
4.	E-Magazine

5.	Thesis
6.	Notebook and Class material
7.	Publication (Articles)

Advanced Research Center (ARS)
The ARS is an electronic research facility focused on management, and mitigation for electronic researches focused on electronics reliability and is dedicated to providing a knowledge and resource base to support the development of competitive ideas and research.

Table (4) Advanced Research Center module suggested services

Number	Models
1.	New topics
2.	Hot topics
3.	Running research
4.	Suggested topic
5.	Idea sharing
6.	Looking for partners
7.	Research feedback
8.	Consulting & Advisory

Academic Live Streaming Model (ALS):
Live streaming refers to Internet content like video and audio delivered in real-time, as events happen. ALS model will allow to users to share and broadcast the academic materials in real time, this model will help a lot of users to attend many academic events remotely and even go further to interact and participate remotely. One of the main features of live streaming that it does not need to be recorded at the origination point, as recording will be optional, this will allow USREC to save all the broadcast material and save it as academic material for future. The main Livestreaming classification will be:

Table (5) Academic Live Streaming suggested services

Number	Models
1.	Courses Broadcasting
2.	Conference and seminars Broadcasting
3.	Defines Broadcasting
4.	Events Broadcasting

Training and learning management model (TLM)
Is a software application model for the administration, documentation, tracking, reporting and delivery of educational courses or training programs. The main aim is to help the instructor deliver material to the students, administer tests and other assignments, track student progress, and manage record-keeping. LMSs are focused on online learning delivery but support a range of uses, acting as a platform for fully online courses.

Academic Opportunities and Announcement Center (AOAC)
This model will be focus having all the academic opportunities and announcement in one place, as it will be useful for all participant and academic organization, as users will find all the opportunities related to academic vacancies, scholarships, conference, training, workshop and promotions in one place, this will allow users to save time instead of searching each academic institutions separately, and for the organization, it will be getting more number of viewers for their announcements and promotions.

Table (6) Academic Opportunities and Announcement Center suggested services

Number	Models
1.	Vacancies
2.	Scholarship
3.	Conference
4.	Training and Workshops
5.	Promotions

Social Academic Network module (SAN):
is a module that brings all USREC users together to talk, share ideas and interests, the main idea of this model is to make all USREC users communication as much as fast and easy for more interactive, collaboration and sharing. An incorporate a range of new information and communication tools, operating on desktops and on laptops, on mobile devices such as tablet, computers and smartphones. Below services will be considered as main part of this module

Table (7) Social Academic Network suggested services

Number	Models
1.	Forums and Chat rooms for (Students, Staff, Guests, Researchers)
2.	Instant messages
3.	Email
4.	Messenger (text, audio, video calls)

USREC SECURITY AND PRIVACY

Protection of sensitive data is key in the educational domain, and there is a special concern about how cloud computing deals with this issue (Bristow, Dodds, Northam, & Plugge, 2010; Johnson et al., 2012). Some contributions (e.g., Pocatilu et al., 2010) have pointed out that cloud computing can be more secure than traditional distributed systems to protect these data. They argue that data is stored in virtual servers unknown to thieves that compromised services can be replaced faster without major costs or damages, and that security and monitoring are centralized and can be dealt with more effectively with high qualified expertise resources. Cloud providers may offer more security measures and expertise than those within educational institutions (McDonald et al., 2010).

Generally speaking, certain aspects of USREC security are very similar to physical local networks and systems. Both are potential subjects of attack, information theft, including espionage and human error. USREC services have. USREC security has to be designed in terms of splitting of responsibilities between the provider and the customer itself, or among multiple providers.

USREC security design will be based on Intel's SaaS Security Reference Architecture, (SaaS Security Best Practices Minimizing Risk in the Cloud- August 2015)

Intel's SaaS security reference architecture uses the following categories of building blocks:

- Application and data security: Various techniques and tools help protect corporate and employee data.
- Identity and access: Identity management, single sign on, and multifactor authentication are just some of the ways we verify that the appropriate people have access to the ap propriate SaaS applications.
- Compliance and governance: Intel use several approaches to meet regulatory compliance

requirements, including educating employees about using the cloud safely. In addition, enterprise
governance controls ensure that SaaS deployments are meeting security policy and privacy
requirements.also review SaaS cloud service providers with respect to the security assurance
of the cloud service and their ability to demonstrate their adherence to industry standards.

- Device security: Intel have established a security framework for device management, including
device registration and security controls. These controls are based on device attributes and security compliance (also known as device posture).
- Security business intelligence (SBI) platform and security operations: This platform serves as the foundation of the
information security efforts, supporting logging, monitoring, incident
response, and advanced analytics.
-

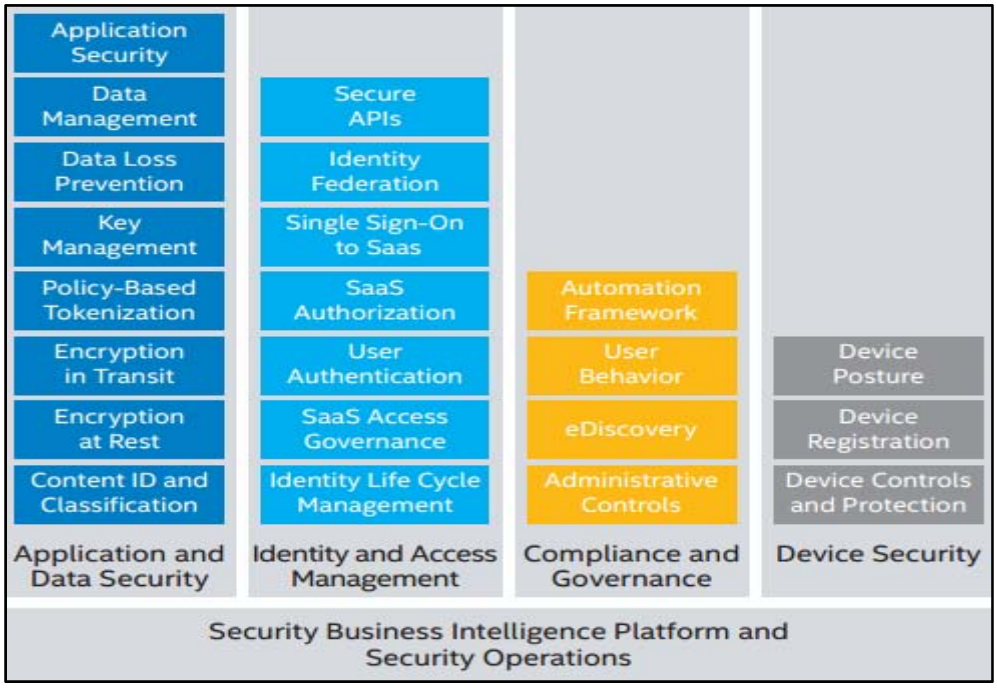

Figure 1. intel SaaS security reference architecture

SaaS security controls have enhanced security, privacy, and legalcompliance at Intel, and are making it safe for business groups to “go fast” when adopting new SaaS solutions like USREC.

Payment Model

The method of payment would be on subscript basis for all users, plus billing for usage, the payment model will be either for institutions or individual users, as describe below:
Institute: as mention above that this solution designed to be flexible for all clients, so for institutions they can chose any model, such they can pick at least one model from all provided models, and the payment will be based on the number of selected model and by choosing one of below two billing option:

- Pay-per-user is the most popular SaaS pricing strategy. Under this model, a separate cost is incurred for each user of a SaaS application. Billing occurs on a periodic basis (usually monthly) for all registered users.
- Second pricing model is pay-as-you-go billing model, which typically charges for the number of users and the amount of resources (e.g. volume of storage space,

CPU usage, etc.) being consumed during a given time period. This pricing model can be beneficial for an organization since they are only required to pay for the actual volume of resources consumed, Billing occurs on a periodic basis (usually monthly) for all registered users.

The billing will be either on monthly, quarterly or yearly bases. Some of these models will be excluded for staff, researchers and others will be for students, with different level of authority depends on the selected model.

Individual users: as the individual users will have limited number of models to pike, so it will be based on the Pay-per-user on monthly, quarterly or yearly bases.

Conclusions

Clear understanding of academic requirements and their relationships with respect to architectural choices is a critical for any academic system transforming the corporate culture into a co-operative business culture by sharing/reusing business processes with help of the cloud services. The biggest challenge in cloud computing is the lack of a single architectural method, which can meet the requirements of an academic organizations cloud approach. In this paper, we explored the architectural features of Cloud Computing and classified them according to the requirements of educational sector and academic institutions that use the cloud as a platform, and cloud providers themselves. We show that Hybrid SaaS architectural design and features will play a major role in the adoption of the Cloud Computing paradigm for USREC as a mainstream commodity in the academic world.

This paper also provides basic guidelines to application architects and Cloud Computing application developers for creating future architectures, moreover the security design was discussed briefly based on Intel SaaS architecture design, On the other hand, USREC brings advantages for educational institutions and their IT staff that can be common to other application domains. In this sense, educational institutions can leverage the cost savings of USREC by relying on clouds because of the scalability and availability offered. Larger cost savings can be achieved if automatic scalability techniques are implemented, though this requires research on defining educational metrics that drive it, and that are also cost-constrained. Regarding the IT staff, virtualization will help to minimize the operation time, making it possible for technical personnel to focus on core tasks instead of configuration issues. Collaboration, sharing and social academic network will be one of the most important benefits for USREC, moreover, having all the academic and research tools and application in one place will make life easier for all users.

Our set of general, and preliminary requirements can be used as the first step towards a more specific set of properties and requirements for the emerging academic cloud services, moreover, new papers will be followed to describe each part of this paper in details.

Reference

Liu, J. Tong, J. Mao, R. Bohn, J. Messina, L. Badger, D. Leaf, NIST cloud computing reference architecture, NIST Spec. Publ. 500 (2011) 292.
N. Grozev, R. Buyya, Inter-cloud architectures and application brokering: taxonomy and survey, Softw. Pract. Exp. 44 (3) (2014) 369–390.
E. Casalicchio, M. Palmirani, A cloud service broker with legal-rule compliance checking and quality assurance capabilities, Procedia Comput. Sci. 68 (2015)136–150. 1st Int'l Conf. on Cloud Forward: From Distributed to Complete Computing.
B.D. Martino, G. Cretella, A. Esposito, Towards a legislation-aware cloud computing framework, Procedia Comput. Sci. 68 (2015) 127–135.

Laisheng, X. and Zhengxia, W. (2011) „Cloud Computing: A New Business Paradigm for E-learning".In IEEE, 716-719
Manro Sunita, Jagmohan Singh and A.S.Joshi (2012) „Managing e-Learning using Clouds: A costeffective boon in 21st century", International Journal of Computers & Distributed Systems, Volume 1, No.1. 11.
Masud, A.H. and Huang, X. (2011) „ESaaS: A New Education Software Model in E-learning Systems, In: Zhu, M. (ed.) ICCIC 2011, Part V. CCIS, vol. 235, pp. 468–475. Springer, Heidelberg.
Christopher S. Yoo (2011) : Cloud Computing: Architectural and Policy Implication, Rev Ind Organ 38:405–421DOI 10.1007/s11151-011-9295-7
Emiliano Casalicchio , Valeria Cardellini , Gianluca Interino , Monica Palmirani Research challenges in legal-rule and QoS-aware cloud service brokerage, Future Generation Computer Systems 78 (2018) 211–223
Birman, K., Chockler, G., & van Renesse, R. (2008). Towards a cloud computing research agenda,http://www.cs.cornell.edu/projects/quicksilver/public_pdfs/SIGACT2.pdf.
Brodkin, J. (2010, June 10). Amazon cloud uses FedEx instead of the Internet to ship data, NetworkWorld, http://www.networkworld.com/news/2010/061010-amazon-cloud-fedex.html.
Buyya, R., Yeo, C., Venugopal, S., Broberg, J., & Brandic, I. (2009). Cloud computing and emerging ITplatforms: Vision, hype, and reality for delivering computing as the 5th utility. Future GenerationComputer Systems, 25, 599–616.Carr, N. (2008). The big switch. New York: W.W. Norton
Foster, I., Zhao, Y., Raicu, I., & Lu, S. (2008). Cloud computing and grid computing 360-degreecompared. In Proceedings grid computing environments workshop: GCE 2008 (pp. 1–10). doi:10.1109/GCE.2008.4738445.
Geelan, J. (2009, January 24). Twenty one experts define cloud computing. Cloud Computing Journal.http://www.cloudcomputing.sys-con.com/node/612375.
Johnson, B. (2008, September 29). Cloud computing is a trap, warns GNU founder Richard Stallman.http://www.guardian.co.uk/technology/2008/sep/29/cloud.computing.richard.stallman.
Mell, P. & Grance, T. (2009, October 7). The NIST definition of cloud computing (version 15). http:// www.csrc.nist.gov/groups/SNS/cloud-computing/cloud-def-v15.doc.
Schmalensee, R. (1984). Gaussian demand and commodity pricing. Journal of Business, 57, S211–S230.Vaquero, L., Rodero-Merino, L., Caceres, J, & Lindner, M. (2009). A break in the clouds: Toward acloud definition. ACM SIGCOMM Computer Communication Review, 39, 50–55.
Weinman, J. (2008, September 7). The 10 Laws of Cloudonomics. GigaOm, http://www.gigaom.com/ 2008/09/07/the-10-laws-of-cloudonomics/.
Weinman, J. (2011b, April 12). As time goes by: The law of could response time, http://www.joeweinman.com/Resources/Joe_Weinman_As_Time_Goes_By.pdf.
Yoo, C. (2010a). Innovations in the Internet's architecture that challenge the status quo. Journal on Telecommunications and High Technology Law, 8, 79–99.
Yoo, C. (2010b). The changing patterns of internet usage. Federal Communications Law Journal, 63, 67–89.
Choudhary, V.: Software as a service: implications for investment in software development. In: Proceedings of the 40th Hawaii International Conference on System Sciences (2006)
Cruz, A.: Gmail site reliability manager, update inGmail. Available online at http://tinyurl.com/b2vzka (2009). Accessed on March 2009
19. DeWitt, D.J., Robinson, E., Shankar, S., Paulson, E.,Naughton, J., Krioukov, A., Royalty, J.: Clustera: an

integrated computation and data management system.In: Proceedings of the Very Large Databases (2008)

Sun, A., & Chen, X. (2016). Online education and its effective practice: A research review. Journal of Information Technology Education: Research, 15, 157-190. Retrieved from http://www.informingscience.org/Publications/3502

Jose A. Gonz alez-Martínez *, Miguel L. Bote-Lorenzo, Eduardo Gomez-S anchez, Rafael Cano-Parra (). Cloud computing and education: A state-of-the-art survey Escuela T ecnica Superior de Ingenieros de Telecomunicacion, Universidad de Valladolid, Paseo de Bel en 15, 47011 Valladolid, Spain.

Amin Y. Noamana, Fekry Fouad Ahmedb(2015) , ERP Systems Functionalities in Higher EducationProcedia Computer Science 65 (2015) 385 – 395, Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND licenseAvailable online at www.sciencedirect.com.

White paper by Intel August 2015, SaaS Security Best Practices
Minimizing Risk in the Cloud- Shachaf Levi, Eran Birk, Esteban Gutierrez, Kenneth J. Logan, Jac Noel, Nooshin Zand, Carlton Ashley, Thai Bui, Paul Matthews.

Spinola, M. (2009). An Essential Guide to Possibilities and Risks of Cloud Computing: a Pragmatic Effective and Hype Free Approach for Strategic Enterprise Decision Making. Retrieved 15/04/2011.

NIST. (2009). NIST Definition of Cloud Computing v15 Retrieved 16/02/2010, from http://csrc.nist.gov/groups/SNS/cloud-computing/index.html

Le Sun, Hai Dong, Farookh Khadeer Hussain, Omar Khadeer Hussain (2014), Journal of Network and Computer Applications 45 (2014) 134–150 Elizabeth Chang Cloud service selection: State-of-the-art and future research directions.

Sheth A, Ranabahu A (2012). Semantic modeling for Cloud computing. Retrieved from: ⟨http://knoesis.org/node/70⟩; 2012 [29.05.13].

Siegel J, Perdue J. (2012), Cloud services measures for global use: the service measurement index (SMI). In: Proceedings of the annual SRII global conference (SRII). San Jose, CA.

Wikipedia, 'HomeBrew' Hybrid SaaS model, available on https://en.wikipedia.org/wiki/Hybrid_SaaS