Benefits of Cloud Computing in Educational Sector

Dr. Mrs. Sunita Mahajan, Harshali Patil Roshan Jaiswal

Abstract--- The world scenario is changing very fast on all fronts and its effect is reflected in the educational institutions in various forms. Most educational institutions have accepted computer as an essential resource for running various courses. The students and faculty use computers in their laboratories for programming projects and for keeping their records. The problem in planning the computer lab is in deciding the future need for high end computing resources. This leads to the fear of obsolescence after every 5 years. And this is a difficult proposition on financial front. Cloud computing provides itself as a very economically viable alternative since the cloud offers computing resources on per need basis.

This paper deals with the paradigm shift to using cloud in the educational environment. Here, we will review how cloud computing services can be utilized in educational sector to provide the required flexibility and ease of use. The face of education is slowly changing. Student/teacher relationship has slowly metamorphosed into client/service provider relationship. So the educational institutes go for providing latest infrastructure, which is available in cloud paradigm.

The paper will provide the comparison of three popular cloud computing commercial networks namely Amazon, Microsoft Azure and Google. In the end there will be a discussion about the benefits and drawbacks of cloud computing.

Index Terms--- Cloud computing, web services, IaaS, SaaS, PaaS, NaaS

I. INTRODUCTION

The recent trend in IT world is tremendous growth of data(Big data)and its demand for more and more storage. Thus is it surprising that cloud concept with its unlimited storage gains more and more popularity to cater to such high end storage demands? The frequency of access, protection, security, storage costs are important factors for cloud stores i.e. data archives. Cloud computing is a highly scalable technology and uses virtualized resources that can be shared by many users. Users do not need any prior knowledge of the services. A user can communicate with many servers at a same time and these servers exchange information among themselves [1].

Dr. Sunita Mahajan Principal, Mumbai Educational Trust-ICS, Mumbai, India, E-mail: sunitam_ics@met.edu
Harshali Patil Associate Professor, Mumbai Educational Trust-ICS, Mumbai, India, E- mail: harshalip_ics@met.edu
Roshan Jaiswal, Assistant Professor, Mumbai Educational Trust-ICS, Mumbai, India, E-mail: roshanj_ics@met.edu

Indian Government is promoting education and encouraging students to complete their basic education as well as creating awareness among parents to send their ward to school regularly. This initiative will help the children to achieve their goals in life. As per the survey conducted by government they have identified that there are many loopholes in the current education system such as scarcity of resources, poor infrastructure etc. To overcome these drawbacks cloud is a best solution.

A new technology trend, Cloud computing tries to fulfill the increasing demands of customers/end users. Providing software as a service is not a new practice in computing. Application service providers (ASPs) were providing businesses with software programs as a service via the medium of the Internet during the 1990s [2]. SOAP-based Web services are now being used in the delivery of some aspects of the new computing paradigm (viz., cloud computing) which not only promises to deliver software remotely but also render other computing-related functionality. It provides relatively new technologies such as virtualization and grid computing [2]. Virtualization is the technology that enables the creation of a virtual (as opposed to actual) version of something e.g. an operating system, a server, a storage device nor network resources. Grid computing is the technology that enables the sharing of tasks over multiple computers (linked together to form a supercomputer). These tasks can range from data storage to complex calculations and can be spread over large geographical areas.

II. WHAT IS CLOUD COMPUTING?

A study by McKinsey (the global management consulting firm) found that there are 22 possible separate definitions of cloud computing. There is no standard definition for cloud computing. A commonly used definition states cloud computing as clusters of distributed computers which provide on-demand resources and services over a networked medium [2]. McKinsey suggests that "using clouds for computing tasks promises a revolution in IT similar to the birth of the web and e-commerce." [3] Burton Group concludes that "IT is finally catching up with the Internet by extending the enterprise outside of the traditional data center walls."[4]

The following are the types of services offered by cloud computing [2, 5]:

- Infrastructure as a Service (IaaS): the services offered using this type includes infrastructure sharing such as virtual servers, storage devices, network medium, load balancers, virtual computers etc. It can be used to fulfil the infrastructure needs of the students, faculties, managing authorities, researchers and affiliated bodies

by providing specific hardware configuration for a specific task.

- Platform as a Service (PaaS): In traditional computing model where everything is managed locally, it requires operating system, databases, middleware, web servers, clients, hardware and other related computing software. To keep information system setup in function we need a team of experts with specific skill set. In short, the experts in databases, hardware, and system management play an important role in traditional computing. With cloud computing, these services are now provided remotely by cloud providers under this layer. Providers are available on Internet to facilitate customers to build their own applications with ease and without the cost. The complexity of purchasing and managing the underlying hardware and software layers is avoided in this layer of cloud computing.

- Software as a Service (SaaS): The services offered in this type are, applications that are delivered through Internet. The user will get facility without installing and maintaining the software. Thus it cuts down the maintenance and support activity at user end. The access becomes easy via Internet. The applications delivered as service can have functionality like email, games, corporate type applications, office related applications, Customer Relationship Management applications, Enterprise Resource Management applications etc. The facility provided by this layer to user will be the applications hosted by application service provider. The applications which can interact through web browsers, hosted desktop or remote client.

- Network as a Service (NaaS): the services offered by this type are network/transport connectivity services and/or inter-cloud network connectivity services. It includes the optimization of resource allocations by considering network and computing resource as a unified whole [6]. The traditional services include bandwidth on demand. Consider a university which has affiliated colleges scattered across state boundaries, offering multiple courses. University forms a network of all colleges running a specific course which requires on demand connection of course-specific network. It should be possible to include same college node into another network of a different course work. Such flexibility is only accessible in cloud.

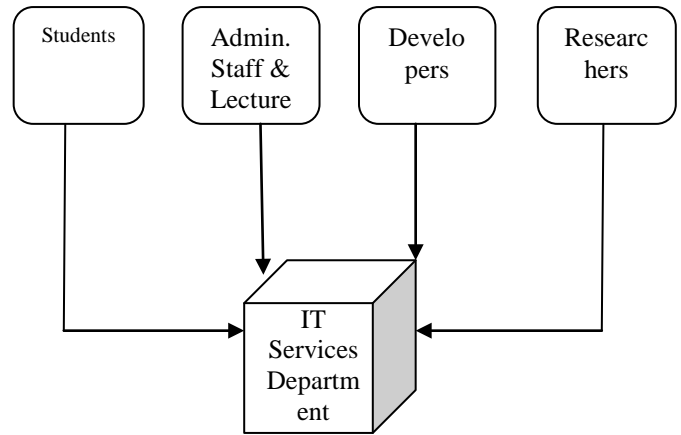Let us consider a simplified architecture for university cloud users [2]

Figure 1: Simplified structure of the main users of IT services in a typical university.

Following figure shows the university using the services of cloud computing. [2]
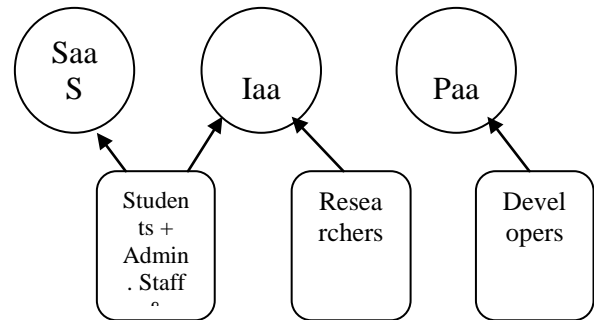

Figure 2: University using the services of cloud computing

III.   CLOUD IS OMNI-PRESENT

Cloud computing is not just a concept technology but it has many commercial implementations. Let us consider three most popular cloud providers, Amazon, Google and Microsoft.

Amazon's Elastic Compute Cloud (EC2) offers a variety of services and it represents a virtual computing environment that allows users to rent virtual computers on which they run their computer applications. The users will use the web service interfaces through which a user can boot an Amazon machine image to create a virtual machine. User can create, launch and terminate server instances as needed, paying by the hour for active servers. Amazon's other cloud, known as S3 (or simple storage service), provides a web services interface that can be used to store and retrieve any amount of data, at any time, from anywhere on the Web. The developers can access reliable, highly scalable, fast, inexpensive data storage infrastructure [2].

Google provides a variety of cloud services. A popular service is Google Apps. Google Apps is a collection of Web-based messaging such as Gmail, Google Hangouts, and Google Calendar and productivity and collaboration tools such

as Google Docs: text files, spreadsheets, and presentations. Google framework of cloud applications has become popular in a very short time and has already crept silently into the life of young students and also academicians.

Not to be outdone, Microsoft also came up with new computing service delivery model as Azure and developed it in three flavors. Windows Azure not only provides on demand compute and storage to host, it also manages and scales the web based applications. SQL Azure actually is an extension to Microsoft SQL Server and works as a web based distributed relational database. Azure .Net Services (which include a set of Microsoft hosted, highly scalable, developer-oriented services) provide key building blocks required by many cloud-based and cloud-aware applications)

IV.   COMPARISON OF THREE MOST POPULAR CLOUD SERVICE PROVIDERS

The comparison is done on the basis of three parameters: computation, storage and network [10].

A.   Computation
- Amazon Web Services

Amazon Elastic Compute Cloud (Amazon EC2) provides basic computation service in AWS. It presents a virtual computing environment and enables resizable compute capacity. Users can simply use a pre-configured Amazon Machine Image (AMI) (pre-configured operating system and application software) or create their own AMIs. Users can then choose between different instance types with different virtual CPU cores and amount of memory. There are also special types of instance to meet various application needs, e.g. High-CPU/ Memory/ I/O Instances, Cluster Compute Instances for High Performance computing (HPC) and network-bound applications, Cluster Graphics Processing Unit (GPU) Instances and Elastic Block Store (EBS) -Optimized Instances enable Amazon EC2 instances to fully utilize the Input Output Operations Per Second (IOPS) provisioned on an EBS volume. EC2 instances can be launched in multiple locations (Regions and Availability Zones). Failures are insulated among different Availability Zones. Regions are geographically distributed and consist of one or more Availability Zones. Amazon EC2 offers Auto Scaling and Elastic Load Balancing services also. Auto Scaling allows users to scale-up/down their EC2 capacity automatically when pre-define events are triggered. Elastic Load Balancing automatically distributes incoming traffic across multiple Amazon EC2 instances, which brings improved responsiveness as well as fault tolerance.

- Windows Azure

Windows Azure Virtual Machines provides IaaS similar to EC2. To create a VM, users need to choose a virtual hard disk (VHD) for the VM's image. Users can either use VHDs provided by Microsoft (Windows Server) and its partners (Linux images), or upload their own VHDs. Then users need to specify the size of new VM (different number of cores and amount of memory).

- Google

Google Cloud Platform contains a suite of products that allows users to build applications and websites, store and analyze data on Google's infrastructure. Google Compute Engine is the IaaS cloud platform that offers flexible VMs hosted on Google. Currently it is still in limited preview stage and is open by invitation only and preferably to those with large computational workloads. It only supports Linux based virtual machines running on KVM hypervisor right now. Users can choose the specific location (called zone) to launch instances. A zone is defined by a tuple (region, availability group) which is similar to another tuple (region, availability zone) in AWS.

B.   Storage
- Amazon Web Services

EC2 instances come with a virtual local disk, but data in this disk may be lost if the instance fails. AWS provides EBS offers persistent storage to EC2 instances and is independent from instance life. EBS provides block level storage volumes and can be mounted as devices by running EC2 instances. EBS behaves like a raw/unformatted block device and users can create a file system on it.

Amazon Simple Storage Service (S3) is fully redundant data storage for the Internet. Amazon Glacier provides extremely low cost storage specifically for data archiving and backup. It is optimized for data that is infrequently accessed and retrieval of data may take several hours. AWS Storage Gateway service allows users to back up of on premises application data to Amazon S3 for future recovery. AWS Import/Export service offers faster data transfer into and out of AWS by using portable storage devices rather than transferring data via the Internet.

Amazon offers Relational Database Service (Amazon RDS) to give users access to the capabilities of MySQL, Oracle or Microsoft SQL Server database engine. Amazon SimpleDB provides NoSQL database service for smaller datasets and Amazon DynamoDB provides fully managed, high performance, NoSQL database service.

- Windows Azure

Windows Azure Blob provides storage to store large amounts of unstructured data. A blob is a file of any type and size. There are two types of blobs in Windows Azure storage: block and page blobs. Block blobs consists of blocks (each block up to 4MB) and are efficient when uploading large blobs. Most files are block blobs. Page blobs are a collection of 512 byte pages optimized for random read and write operations. Page blobs are more efficient when ranges of bytes in a file are modified frequently. Each VM is associated with an OS disk (if a provided VHD is used to create a VM, that VHD is copied to VM's OS disk) and one or more data disks. Each disk is stored in a blob which is replicated both within a single data-centre and across data-centers.

Microsoft provides Windows Azure SQL Database as a relational database option. Windows Azure Table is a NoSQL data-store which is ideal for storing structured, non relational

data. Windows Azure Queue is a service for storing large numbers of messages that can be accessed from anywhere.

- Google

Each VM in Google Compute Engine has an ephemeral disk (by default 10GB) tied to the lifetime of VM instance. Users can request persistent disks which are independent disks which could out live an instance's lifespan. Data written to persistent disks is automatically replicated across multiple disks in data-centers. During current Limited Preview period, specific zones may be taken down for maintenance and upgrades. Data on ephemeral disks will be lost during the maintenance window period. Data on persistent disks will still be there, but users need to migrate their persistent disks ahead of time manually with FTP or rsync.

Google Cloud Storage is a service for developers to store and access data in Google's cloud and is similar to Amazon S3. Developers can store objects and files up to terabytes and manage access to the data. All data is replicated to multiple data centers for high availability. Google Cloud SQL is a relational SQL database service based on MySQL and is good for medium or small data sets.

C. Networking

- *Amazon*

By default, a VM instance in AWS or Windows Azure is standalone and with its own public IP address. Amazon Virtual Private Cloud (VPC) and Windows Azure Virtual Network (VNET) allow users to groupVMs into a private and isolated network in the cloud. In a VPC/VNET, users can define the virtual network topology and have complete control over private IP address range (all VMs in the same VPC/VNET can be accessed through a single public IP address), creation of subnets, and configuration of route tables and network gateways.

To extend on premises data-centre into the public cloud, Amazon and Windows Azure both provide solutions for hybrid cloud. In VPC/VNET, users can create an encrypted IPsec hardware VPN connection between corporate VPN gateway and VPC/VNET. Compared to a VPN connection over the Internet, Amazon offers another network service called AWS Direct Connect which is suitable for high bandwidth and latency sensitive applications. Direct Connect uses industry standard 802.1Q VLANs to establish a dedicated and private connection between premise to AWS. Since it is hard for VPN hardware to support data transfer rates above 4 Gbps, users can easily get more network capacity with multiple Direct Connect connections, each with 1 Gbps or 10 Gbps. One nice thing is this dedicated connection can be partitioned into multiple virtual interfaces. So the same connection could be used to access both public resources (e.g. objects in Amazon S3) and private resources (e.g. EC2 instances in VPC), or access multiple VPCs.

- *Windows Azure*

Windows Azure Connect provides agent based, machine to machine connections between Windows Azure services and on premises resources. With Windows Azure Connect, VMs in Windows Azure can join the domain on premises. So VMs in Windows Azure have IP addresses that look like other networked resources in the same domain rather than use external virtual IP addresses. This greatly helps domain management (e.g. authentication, name resolution, domain wide maintenance, and remote debug) and distributed application development (e.g. a web application hosted in Windows Azure can securely access an on premise SQL Server database server).

Windows Azure also offers Traffic Manager to load balance incoming traffic across multiple Windows Azure services, ensure high availability and improve the responsiveness by serving end users with the closest service.

- *Google*

Each VM instance in Google Compute Engine belongs to a single network, which defines the address range and gateway address of all instances connected to it. Users can specify firewall rules for an instance. An instance can get an external IP address when it is started. Traffic between the instance and the Internet or other instances in different networks will use this public IP address. An instance without an external IP address can only access instances in the same network.

V. PARADIGM SHIFT IN EDUCATION TOWARDS CLOUD

Cloud computing has various advantages like if we implement cloud in education it can be accessible from anywhere. Software used are either free or we have to pay pro rata basis as against buying the entire software package thus giving us a cost effective services. Access will be available 24X7 to infrastructure and contents. The initiative like green technology helps to protect environment, increasing functional capabilities, increased openness to students to access new content [8]. Because of higher accessibility, availability and efficiency of cloud services many universities, business organizations, governing bodies are trying to make effective use of these services. Today's cloud computing providers are offering education related services, it is an opportunity to provide their data and information in the 'cloud' for universities with existing data centers, servers and application replacing these traditional campus machines. Cloud architecture can be developed according to the purpose and infrastructure of the institution. The university will provide a cloud for education, abiding to the rules and regulations of state and country policies. Cross border content availability feature decision has to be taken to apply the security features on the cloud. As the university identifies where their data will reside and gives the measure of data security an agreement called SLA(Service Level Agreement) can be made with the cloud-service provider. This SLA documentation will provide services information that education cloud users can use. Cloud makes the integration simple and easy to access [5, 9]. Privacy of data is a main concern in cloud computing so service provider may ask certain personal information which is related to the data on cloud. Universities implementing cloud should always take care about integrity of educational data.

A. Case study:

- Mumbai University

University of Mumbai has more than 25000 students and is always ready to provide new technology solutions to their students, faculties, institutions. In past few years due to traditional system loopholes, university has undergone various misconducts in examinations. To overcome this problem, University of Mumbai has started using online services for the examination system. The basic requirement for implementation is high speed internet connections, web browser, mobile phone and printing devices. University of Mumbai implemented two level securities for accessing the exam data in current system. The implementation of this system facilitates smooth conduct of examination scheduled by University. In current system Institute head and IT administrator have been provided one time login id and password to get access of the system and then daily a new password is provided to extract question papers from the system. This reduces the threat of data theft. The password communication is done through mobile phones and the authenticity of password and web contents related to examination, are available on server for the specific time period. Thus managing two level securities reduces the hassle in examination conduct.

Cloud implementation provides a cleaner solution for University examination system. In current system, each question paper is designed by three subject experts. Human intervention is there in current system. To automate the task of question paper generation the cloud based system will maintain a database of question bank at cloud's disk storage. Random selection of questions will be done for designing a question paper. These question papers will be made available on cloud for specific time period. Institute head will be given access of this database through password. A separate password management system is used for security of examination system. Cloud implementation not only provides infrastructure with low maintenance but also facilitate the end users with digital library, ebooks, lecture notes, videos, software etc.

- *A Distant Village in Hilly Area*

A village near the Satpuda hills at Maharashtra has shown a progressive attitude by having one degree college offering BCA course for girls, which is in such a remote place that actually setting up a Computer lab with complete hardware and software is difficult. The computer boxes have to be ferried across a difficult terrain. The maintenance of such a lab is another preposition altogether. Computer spares are not available easily. The college is attached to the University in urban area and likely to go for a syllabus change often to suit the changing needs of the Industry. So the lab set up in such a village as Mokhada is in the danger of becoming obsolete and may lead to financial loss as an additional disadvantage.

The scenario changes if the College decides to shift to Cloud. The computer lab will consist of only thin computers (without hard disk) requiring less maintenance and no fear of constant up gradation. The College management can requisition cloud resources (hardware and software) as per the need and get the full capacity virtual lab, thus providing necessary computing resources.

VI.   CONCLUSION

Cloud computing is an emerging technology which provides an opportunities for delivering verity of services which has not used before. It not only provides us a low cost solution but helps us to keep environment safe with green technology. The shift towards cloud in education sector will provide benefits such as uniform course material, infrastructure, virtual resources etc. at very low maintenance and support cost. The users of cloud can access data from anywhere. The university can provide course access across state border and students will be able to access the same content from anywhere. Cloud computing is a best solution in education sector in the present scenario of financial crises.

Students and administrative personnel can get an on-demand quick access of various application platforms and resources through the web pages. This feature reduces the cost of organizational expenses and offers more powerful functional capabilities. The cloud can be used to conduct online survey of user requirements; feedback of services provided at various institutes. Cloud provides advantages such as instant global platforms, elimination of Hardware/Software capacities and licenses, reduced cost, simplified scalability. The risks such as failures of server will be reduced by implementing redundant network access.

Life is not a bed of roses. Cloud concept has some pitfalls also. Now consider the disadvantages. Customers require more services than currently provided by the cloud service providers. There are service level agreements, constraints with applications and the fear of storing sensitive data at a remote place not under one's jurisdiction. There is no uniformity in providing services. Some services that are offered by vendors as infrastructure come as SaaS or Paas with other vendors. There is scope for improvement in cloud computing paradigm. However, there is no denying the fact that the cloud offers a simple, flexible and cost effective solution to cater to growing demands of better computer infrastructure at the end of every 3 years.

REFERENCES

[1] Tuncay Ercana, "Effective use of cloud computing in educational institutions", Procedia Social and Behavioural Sciences 2 (2010) 938–942

[2] Nabil Sultan, "Cloud computing for education: A new dawn?", International Journal of Information Management 30 (2010) 109–116

[3] McKinsey& Co., Clearing the Air on Cloud Computing, discussion document. March 2009, p. 2.

[4] Drue Reeves et al., Cloud Computing: Transforming IT, Burton Group Cloud Computing In Depth Research, v1, April 20, 2009, p. 7.

[5] Saju Mathew, "Implementation of Cloud Computing in Education – A Revolution", International Journal of Computer Theory and Engineering, Vol. 4, No. 3, June 2012

[6] Ericsson, "Cloud computing in Telecommunications", Dec 2012

[7] http://www-935.ibm.com/services/in/en/cloud-enterprise/

[8] Marinela Mircea and AncaIoana Andreescu, "Using Cloud Computing in Higher Education: A Strategy to Improve Agility in the Current Financial Crisis", IBIMA Publishing Communications of the IBIMA, Vol. 2011 (2011), Article ID 875547, 15 pages

[9] R. Kandukuri, V. R. Paturi, and A. Rakshit, "Cloud Security," in proceedings of the 2009 IEEE International Conference on Services Computing, Washington, DC, USA, 2009, IEEE Computer Society, pp. 517-520.

[10] Michael Armbrust et al. "Above the Clouds: A Berkeley View of Cloud
      Computing" Electrical Engineering and Computer Sciences University of
      California at Berkeley Technical Report No. UCB/EECS-2009 28
[11] http://www.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-
      28.html,pp 1=25