B.Sc. in Computer Science and Engineering Thesis

Cloud Based Application Server for Universities : A New Approach

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CERTIFICATION

This thesis paper titled **"Cloud Based Application Server for Universities : A New Approach"**, submitted by the group of students as mentioned below has been accepted as satisfactory in partial fulfillment of the requirements for the degree B.Sc. in Computer Science and Engineering on December 2013.

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CANDIDATES' DECLARATION

This is to certify that the work presented in this thesis paper is the outcome of the investigation and research carried out by the following students under the supervision of Group Captain Md. Afzal Hossain, psc, Head of the Department, Department of Computer Science and Engineering, Military Institute of Science and Technology.

It is also declared that neither this thesis paper nor any part thereof has been submitted anywhere else for the award of any degree, diploma or other qualifications.

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ACKNOWLEDGEMENT

We are thankful to Almighty Allah for His endless blessings towards the successful completion of this thesis. Our heartiest gratitude, profound indebtedness and deep respect go to our supervisor Group Captain Md. Afzal Hossain, psc, Head of the Department, Department of Computer Science and Engineering, Military Institute of Science and Technology, for his constant supervision, affectionate guidance and continued encouragement and motivation. His keen interest on the topic and valuable advices throughout the study was of great help in completing our thesis.

We are especially grateful to the Department of Computer Science and Engineering (CSE) of Military Institute of Science and Technology (MIST) for providing all out support and facilities during the thesis work. Our heartfelt indebtness goes to Horoppa Systems, the leading cloud computing provider in Bangladesh for their technical support and motivation towards our research.

Finally, we would like to thank our families and our course mates for their appreciable assistance, patience and suggestions during the course of our thesis work.

Dhaka
December 2013

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ABSTRACT

In the new era of technology it is often said “Now the generation is changing in every six months or less”. From this very small sentence we can understand the rapid development and growth of technology globally. Every single person is connected with data highway in various ways. But the more users are being connected, it is obvious that the performance of computing must be degraded. The most important matter here, we are concerned about the resources used in computing. Much more use of resources, whether it is hardware or software, will increase the cost of computing. Cloud computing, in this situation, gives us relaxation as it is the key way to keep computing cost within our limit. For all types of computing environment cloud plays a great role for resource sharing. Specially if we think about an academic environment of an educational institute, here a lot number of users do the same type of work for their study, lab work etc. But if cloud can be introduced here, lot of resource requirements can be reduced. We propose a cloud based application server which can be used by all students, faculties and staffs of a university simultaneously.

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LIST OF ABBREVIATION

NIST : National Institute of Standard and Technology

SaaS : Software as a Service

PaaS : Platform as a Service

IaaS : Infrastructure as a Service

API : Application Programming Interface

RDP : Remote Desktop Protocol

AD : Active Directory

RD : Remote Desktop

GUI : Graphical User Interface

PDA : Personal Digital Assistant

GPL : General Public License

ASLR : Address Space Layout Randomization

CHAPTER 1

INTRODUCTION

1.1 Overview

The development of web applications has received significant attention in the past few years. Cloud computing is one of the very important web applications that is also recently developed. It helps us in many ways. We can use this service in our educational sector especially in universities. It is a subscription-based service where we can obtain networked storage space and computer resources. One way to think of cloud computing is to consider our experience with email. Our email client, if it is Yahoo, Gmail, Hotmail and so on, takes care of housing all of the hardware and software necessary to support our personal email account. When we want to access our email we open our web browser, go to the email client, and log in. The most important part of the equation is having internet access. Our email is not housed on our physical computer; we access it through an internet connection, and we can access it anywhere. If we are on a trip, at work, or down the street getting coffee, we can check our email as long as we have access to the internet. Our email is different than software installed on our computer, such as a word processing program. When we create a document using word processing software, that document stays on the device we used to make it unless we physically move it. An email client is similar to how cloud computing works. Except instead of accessing just our email, we can choose what information we have access to within the cloud. User can be facilitated with the softwares, hardwares and infrastructure services available in the cloud without having those resources in their individual terminals. This is all about a broad idea about the internet cloud as well as Cloud Computing.

1.2 Approach to Cloud Computing

As the necessity increases people started to search for options to get a better service in terms of virtual storage and in terms of flexibility of using. Cloud computing is found as a better option in this regard. Now a day's various communities like researchers, students, business, consumers and government organizations have sought the attention of cloud computing. Large data size is the main reason for coming of cloud computing in the show. Everyday lots of data are being uploaded in the digital world which requires lots of storage and computing resources. Cloud computing can be a good way of solving this problem. It is a term which is also known as utility computing service as software, platform and infrastructure as a service to consumers. Cloud computing, the long held dream of computing as a utility, has the potential to transform a large part of the IT industry, making software even more attractive as a service.

1.3 Cloud Computing Services

When we store our photos online instead of on our home computer, or use webmail or a social networking site, we are using a "cloud computing" service. If we are an organization, and we want to use, for example, an online invoicing service instead of updating the in-house one we have been using for many years, that online invoicing service is a "cloud computing" service. Cloud computing refers to the delivery of computing resources over the Internet. Instead of keeping data on our own hard drive or updating applications for our needs, we use a service over the Internet, at another location, to store our information or use its applications. Cloud services allow individuals and businesses to use software and hardware that are managed by third parties at remote locations. Examples of cloud services include online file storage, social networking sites, webmail, and online business applications. The cloud computing model allows access to information and computer resources from anywhere that a network connection is available. Cloud computing provides a shared pool of resources, including data storage space, networks, computer processing power, and specialized corporate and user applications.

1.4 How can we use the Cloud?

The cloud makes it possible for us to access our information from anywhere at any time. While a traditional computer setup requires us to be in the same location as our data storage device, the cloud takes away that step. The cloud removes the need for us to be in the same physical location as the hardware that stores our data. Our cloud provider can both own and house the hardware and software necessary to run our home or business applications. This is especially helpful for businesses that cannot afford the same amount of hardware and storage space as a bigger company. Small companies can store their information in the cloud, removing the cost of purchasing and storing memory devices. Additionally, because we only need to buy the amount of storage space we will use, a business can purchase more space or reduce their subscription as their business grows or as they find they need less storage space. One requirement is that we need to have an internet connection in order to access the cloud. This means that if we want to look at a specific document we have housed in the cloud, we must first establish an internet connection either through a wireless or wired internet or a mobile broadband connection. The benefit is that we can access that same document from wherever we are with any device that can access the internet. These devices could be a desktop, laptop, tablet or phone. This can also help our business and education to function more smoothly because anyone who can connect to the internet and our cloud can work on documents, access software, and store data. Imagine picking up our smart phone and downloading a pdf document to review instead of having to stop by the office to print it or upload it to our laptop. This is the freedom that the cloud can provide for us or our organization and institution. So using the cloud is not a very tough task and everybody can do it who is issued with an id and password to access that specified cloud. In this case 'pay per use' method is followed usually.

1.5 Cloud Computing for Education

Education has been gradually expanded and the education object has slowly turned to social stuff. The teaching method from black board to online is growing faster than ever. An online tutor helps to take class in any hour is an advancement of learning using technology. E-learning and online solution is what we require in education environment. With the increasing number in receiving education, a series of new problems have emerged. For

example: As teaching methods change, the existing teaching-learning methods cannot meet demand; and with the constant expansion of education, the existing teaching facilities also need to constantly update. When Cloud Computing appears, it provides a new solution to establish a unified, open and flexible network teaching platform and reduce the hardware input. So cloud computing can play a vital role to ease our educational system. Educational institutions like universities should take the opportunities of cloud computing to the fullest.

1.6 IT Support in Education Sector of Bangladesh

The Bangladeshi education sector is constrained by cost but demand has been rising for cost-effective, robust software applications to deliver services for learning and administration. Existing systems are not scalable and require huge capital expenditure and number of IT staffs to maintain the system, which has shifted the focus from the core education business to managing the overheads of IT operations. The Cloud Computing paradigm has emerged as the optimal solution to meet the requirements of cost effective, scalable, and secure systems. For example, Google Apps for Education Suite comprises Google Mail, Calendar, Talk, Docs, Sites and Video with zero cost and without advertisements [1], According to a Forrester cost analysis [2][3], Google Apps is more effective than a Microsoft Exchange e-mail. The deployment of cloud computing in the education sector in Bangladesh can meet these challenges. Internet is the resource where we can transform cloud computing, it can deliver the most advanced software and educational materials, hardware resources and services to students and educators in even the most impoverished or remote places in the country, without the need for advanced IT expertise at those locations. The aim of cloud computing in education sector is to provide a global forum for educators, researchers and IT professionals from education industry to pursue cloud computing initiatives, develop skill and share best practices for reducing operating costs while improving quality and access to education. In this way users do not need to buy a server, only need to purchase related 'services' can create an efficient network teaching platform. Using of cloud computing by academicians in universities is not aware of benefits and characteristic of minimizing the cost of cloud computing. From an IT-management view, it radically reduces resource management costs -including electric power, cooling and system management personnel, which in turn reduces purchasing requirements.

CHAPTER 2

CONCEPT OF CLOUD COMPUTING

2.1 General Idea

Cloud computing gets its name as a metaphor for the internet. Cloud computing is the delivery of computing as service rather than a product, whereby shared resources, software, and information are provided to the computers and other devices as a utility (like the electricity grid) over network (typically the Internet). The National Institute for Standards and Technology (NIST), Information Technology Laboratory offers this definition of Cloud Computing. It's as good as any. "Cloud computing is a model for enabling 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 services provider interaction"[4].

Figure 2.1: Cloud Computing

Cloud computing is a marketing term for technologies that provide computation, software, data access and storages services that do not require end-user knowledge of the physical location and configuration of the system that delivers the services. A parallel idea to this concept can be drawn with the electricity grid, wherein end-users consume power without

needing to understand the component devices or infrastructure required to provide the service.

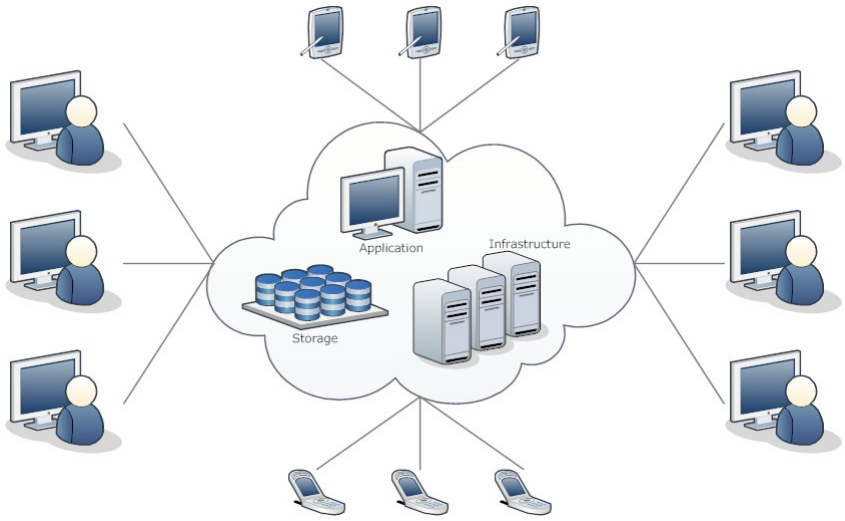

Figure 2.2: Cloud Hosting

As we don't have to buy equipment, so the experience cost will be fewer. By having someone else host the applications, we need not buy the server nor pay for the electricity to power and cool them. It's also convenient for telecommuters and traveling remote workers, who can simply log in and use their applications wherever they are.

2.2 Advantages of Cloud Computing

There are several advantages of cloud computing and some of them are presented below:

- Price: It is easy to see that start-up enterprise companies do not have to invest huge sums of money into setting up infrastructure such as huge applications servers, data servers, database administrators, people resources for managing such critical system including backup and recovery, etc. Instead, enterprise companies pay for services based on usage.
- Simplicity: It is simple to use and set up the services without having to worry about resource management and others hassles that come with infrastructure set up and management.

- Reliability: Network and data access guaranteed to be reliably maintained as the services provides are exerts in maintaining the infrastructure and such reliability is backed by some kind of "money back guarantees" or penalties for the providers in the event if they have a down time.

- Flexibility: Service consumers have the flexibility to outsource parts of the infrastructure and can still maintain to some extent proprietary data at their own site.

- Collaboration: Since all the applications are on the cloud, it becomes a natural fit for consumers to effectively collaborate on a common project or application.

2.3 Issues Related to Cloud Computing

There are several issues related to cloud computing and some of them are presented below:

2.3.1 Privacy and Security

Cloud computing allows users to add more capacity, more services and seamless software patches, despite of existence of encryption and access-control software, some organizations will be hesitant to put their proprietary data on a public-access cloud. From a practical point of view, does the data still remain proprietary if it is stored on a public server? What laws will protect such data in case of software piracy? Cloud who stores data on the memory bank cloud theoretically can access locations outside their space. How is security of the data handled in this case? From both privacy and security points of view, the more restricted the access to the data is, the easier it is to protect it, In order to ensure fast access to data stored and to prevent the loss of data in case of failure of one data center, the user's data may be mirrored on two or more sites, making it even more vulnerable. On the other side, grouping such a massive amount of data in one physical location makes it prone to damage. To prevent such large-scale failures, the data should be stored on sites that are geographically far apart.

2.3.2 Standards

There need to be standards governing regulations with ensure uniformity in how the applications are accessed, stored and modified. Otherwise consumers have fewer options to move their entire operations because of cost considerations. However, with standards, enterprise will have neutrality in packing the service provider. Yet, at this time of writing, none of the entities has started describing such standards. To be effective, major players need to join to agree on standards.

2.3.3 Legality

Who owns the enterprise data? Do the service provides also have ownership? Even if non-disclosure agreement is signed, these might be waived when government agencies are involved. This begs the question whether the client might be ready to forgo the rights of their data. As well, issues arise regarding intellectual property rights when data services are hosted by a third party site.

2.3.4 Mentality

For wide acceptance of cloud computing it requires consumers to relinquish the ownership mentality some extent and to develop a somewhat boarder mindset. Indeed once service for cloud computing is accepted; it will be hard to go back to older ways.

2.3.5 Pricing Theory

If prices do become prohibitive then pricing theories and mechanism need to be revisited certainly in the long run. Are the services provides willing to give discount based n length of usage, frequency of usage, etc.? It is hard to impose limits on a free market where survival of the company depends on cloud computing services employed.

2.4 Cloud Components

In a simple topological sense, a cloud computing solution is made up of several elements: clients, the datacenter and distributed servers. These components make up the three parts of a cloud computing solution. Each element has a purpose and plays a specific role in delivering functional cloud-based applications.

2.4.1 Clients

Clients are, in a cloud computing architecture, the exact same thing that they are in a plain, old, everyday local area network (LAN). They are, typically, the computers that just sit on your desk. But they might also be laptops, tablet computers, mobile phones or PDAs- all big drivers for cloud computing because of their mobility. Anyway, clients are the devices that the end users interact with to managing their information on the cloud. Clients generally fall into three categories:

- Mobile: Mobile devices include PDAs or smart phones, like a Blackberry, Windows Mobile Smartphone or an iPhone.
- Thin: Clients are computers that do not have internal hard drives, but rather let the server does all the work, but then display the information.
- Thick: This type of client is a regular computer, using a web browser like Mozilla Firefox or Internet Explorer to connect to the cloud.

Thin clients are becoming an increasingly popular solution, because of their price and effect on the environment. Some benefits to use thin client type include:

1. Lower hardware costs
2. Lower IT costs
3. Security
4. Data security

5. Less power consumption

6. Ease of repair or replacement

7. Less noise

2.4.2 Datacenter

The datacenter is the collections of servers where the applications to which we subscribe is housed. It could be a large room in the basement of our building or a room full of servers on the other side of the world that we access via the Internet. A growing trend in the IT world is virtualizing servers. That is, software can be installed allowing multiple instances of virtual servers running on the physical servers.

2.4.3 Distributed Servers

All the cloud severs don't have to be housed in the same location. Often, servers are in geographically different locations. But to us, the cloud subscriber, these act as if they're humming away right next to each other. This gives the service provider flexibility in options and security. For instance, Amazon has their cloud solution in servers all over the world. If something were to happen at one site causing a failure, the service would still be accessed through another site. Also if the cloud needs more hardware, they do not throw more servers in the safe room-they can add them at another site and simply make it part of their cloud.

2.5 Services

The term services in cloud computing is the concept of being able to use reusable, fine grained components across a vendor's network. This is widely known as "as a service". Offering with as a service as a suffix includes trails like the following:

- Low barrier to entry, making them available to small business.
- Large scalability.
- Multi-tenancy which allows resources to be shared by many users.

Devices independence means it allows users to access the systems on different hardware and in different computer system.

2.6 Cloud Service Models

The three service models defined by NIST are essentially a hierarchy:[5]

2.6.1 Software as a Service (SaaS)

It is the capability provided to the consumer running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a Web browser (e.g. Web-based e-mail). The consumer does not manage or control the underlying cloud infrastructure, including network, servers, operating systems, storage, or even individual application capabilities with the possible exception of limited user-specific application configuration setting Software as a Service (SaaS) is the model in which an application is hosted as a service to customers access it via the internet. When the software is hosted off-site, the customer doesn't have to maintain it or support it. On the other hand, it is out of the customer's hands when the hosting service decides to change it. Then idea is that we use the software out of the box as is and do not need to make a lot of changes or require integration to other systems. The provider does all the patching and upgrades as well as keeping the infrastructure running.

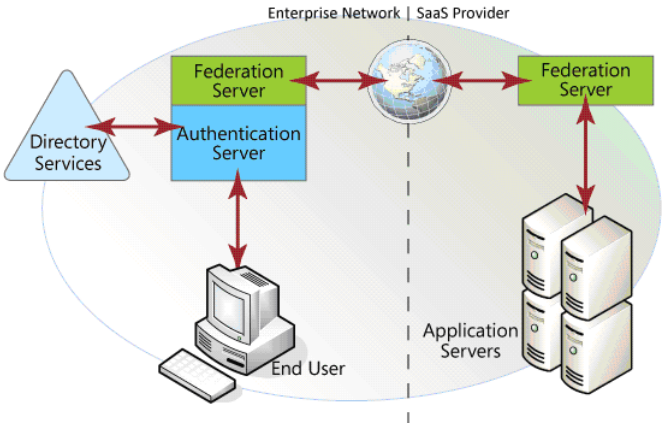

Figure 2.3: Software as a Service (SaaS)

2.6.2 Platform as a Service (PaaS)

The capability provided to the consumer in this intermediate level is to deploy onto the cloud infrastructure consumer-created or acquired applications develop educating programming languages and tools by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems or storage, but has control over the deployed applications and possibly applications hosting environment configurations. PaaS allows clients to access a computing platform over a cloud computing solution.

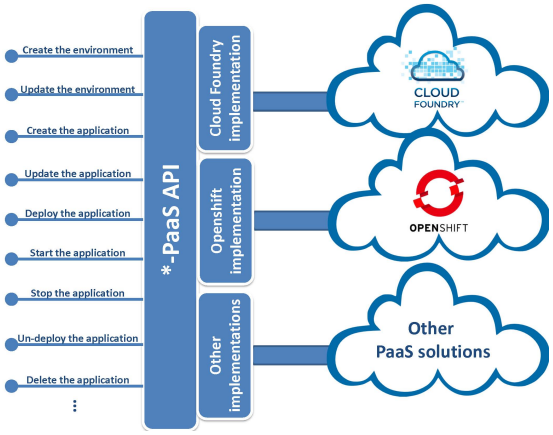

Figure 2.4: Platform as a Service (PaaS)

2.6.3 Infrastructure as a Service (IaaS)

It is the capability to provision processing, storage, networks and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, that includes operation systems and applications. The consumer does not manage but has control over operation systems, storage, deployed applications and possibly limited control to select networking components (e.g. host firewalls).

2.7 Types of Cloud

Four models of cloud deployment are recognized By NIST[6]:

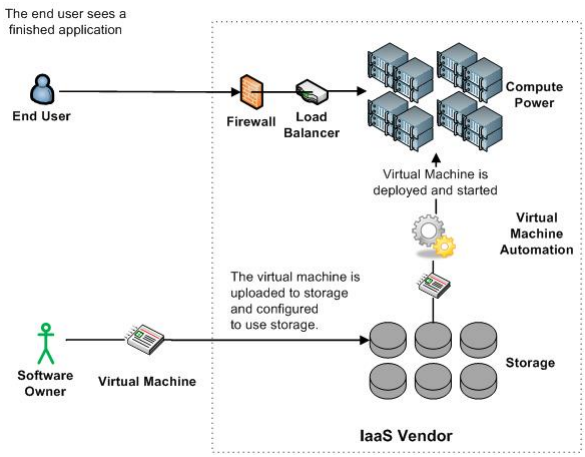

Figure 2.5: Infrastructure as a Service (IaaS)

2.7.1 Private Cloud

The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise. An internal cloud behind the organizations firewall. The company's IT department provides softwares and hardware as a service to its customers the people who work for the company. Vendors love the words "Private Cloud"[6].

2.7.2 Community Cloud

The cloud infrastructure is shared by several organization and supports a specific community that has shared concerns (e.g. mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.

2.7.3 Public Cloud

The cloud is made available to the general public or a large industry group and is owned by an organization selling cloud services. Services offered over the public Internet and available to anyone who wants to purchase the service.[6]

2.7.4 Hybrid Cloud

The cloud infrastructure is a composition of two or more clouds (private or pubic) that remain unique but are bound together by standardized or proprietary technology that enables data and application portability (e.g. cloud bursting for load-balancing between clouds). A networking environment that includes multiple integrated internal and/or external providers. Hybrid clouds combine aspects of both public and private clouds.[6]

2.8 Cloud Application

A cloud application is the software architecture that the cloud uses to eliminate the need to install and run on the client computer. There are many applications that can run, but there needs to be standard way to connect between client and cloud. Cloud applications are a sort of hybrid between traditional applications and traditional web applications. They offer the benefits of both of these types software without many drawbacks. Like desktop apps, cloud applications can offer a rich user experience, immediate response to user actions and offline mode. Like web apps, cloud applications do not need to be installed on a computer and can be updated at any time simply by uploading a new version to the web server. They also store their data in the cloud-offside under own control.

2.9 Differences between Cloud-based and Web-based Applications

Web application is just a small part of cloud computing. Any application which, one can run on his/her home PC or laptop, processing or server like Google earth or for that matter any GUI oriented site running on browser is Web app. Now on the other hand, Cloud computing is computer resource providing type of utility computing. One can buy or get software, platform or even processing from cloud. One can ask for resources from web app. At the back-end the work will be done by a massive collection of servers and computers which is known as cloud. Web based applications are now a subset of cloud-based applications. In this case Facebook can be taken as a parameter to describe.

CHAPTER 3

CLOUD COMPUTING STRUCTURE

3.1 Purpose of Research

Students' learning is no longer confined within the classroom in the era of e-learning. The environment of IT education could be improved to let student access learning resources anywhere. The free software can be adopted for constructing the cloud computing service for the environment of IT like OpenOffice.org such as word processing, spreadsheets, and presentations. Only a browser is needed for students to connect to the cloud computing service for learning. Therefore the purpose of the research is to find the advantages of cloud computing that can be utilized for academic perspectives.

3.2 Cloud Computing Platforms

Open-source software has provided the foundation for many cloud computing implementations, prominent examples being the Hadoop framework and VMware's Cloud Foundry. In November 2007, the Free Software Foundation released the Affero General Public License, a version of GPLv3 intended to close a perceived legal loophole associated with free software designed to run over a network. Most cloud providers expose APIs that are typically well-documented (often under a Creative Commons license) but also unique to their implementation and thus not interoperable. Some vendors have adopted others' APIs and there are a number of open standards under development, with a view to delivering interoperability and portability. As of November 2012, the Open Standard with broadest industry support is probably OpenStack, founded in 2010 by NASA and Rackspace, and now governed by the OpenStack Foundation. OpenStack supporters includeAMD, Intel, Canonical, SUSE Linux, Red Hat, Cisco, Dell, HP, IBM, Yahoo and now VMware.

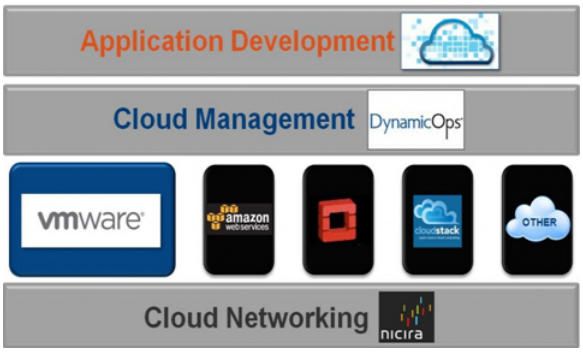

Figure 3.1: Cloud Platforms

3.3 OpenStack

OpenStack is a cloud operating system that controls large pools of compute, storage, and networking resources throughout a datacenter, all managed through a dashboard that gives administrators control while empowering their users to provision resources through a web interface. It is to produce the ubiquitous Open Source Cloud Computing platform that will meet the needs of public and private clouds regardless of size, by being simple to implement and massively scalable. The modules of OpenStack are

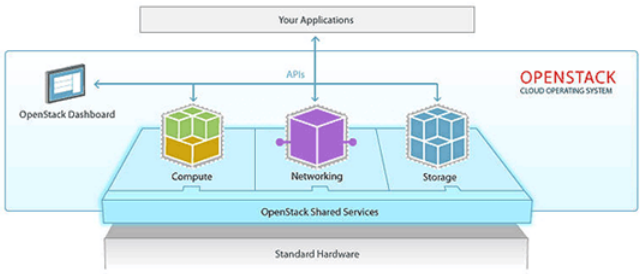

Figure 3.2: OpenStack Working Procedure

1. OpenStack Compute (Nova)
2. OpenStack Image service (Glance)
3. OpenStack Networking (Neutron)
4. OpenStack Object Storage (Swift)
5. OpenStack Block Storage (Cinder)

The members of OpenStack are listed in the figure below

Figure 3.3: Members of OpenStack

3.4 Cloud Service Models

- Software as a Service (SaaS): Provides applications over a network. In this model, user is provided with access to application softwares often referred to as on-demand softwares. User doesn't have to worry about the installation, setup and running of the application. Service provider will do that for him/her. User just have to pay and use it through some client. Examples : Google Apps, Microsoft Office 365.

- Platform as a Service (PaaS): Deploy customer-created applications to a cloud. This model provides the user computing platforms which typically includes operating system, programming language execution environment, database, web server etc. Examples : AWS Elastic Beanstalk, Heroku, Force.com, Google App Engine.

- Infrastructure as a Service (IaaS): Rent processing, storage, network capacity are the infrastructure as a service. This model provides the user the computing infrastructure, physical or (quite often) virtual machines and other resources like virtual-machine disk image library, block and file-based storage, firewalls, load balancers, IP addresses, virtual local area networks etc. Examples : Amazon EC2, Windows Azure, Rackspace.

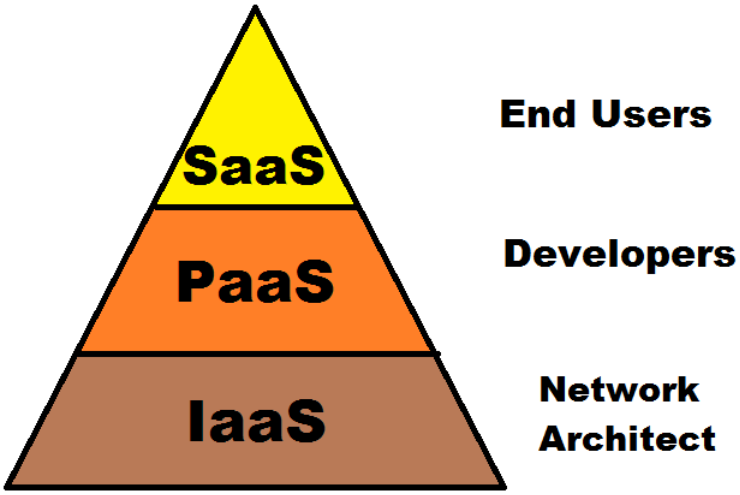

Figure 3.4: Cloud Service Model

3.5 Cloud Computing for Universities

A Cloud-computing service that will let universities and colleges build custom private clouds that can be integrated into public cloud services. Three main factors that generate interests in Cloud Computing are:

1. Rapid decrease in hardware cost and increase in computing power and storage capacity; the advent of multi-core architecture and modern supercomputers consisting of hundreds of thousands of cores.

2. The exponentially growing data size in scientific instrumentation/simulation and Internet publishing and archiving.

3. The wide-spread adoption of Services Computing.

For example, a university student taking a math or computer course could access a cloud from his room, to obtain a physical or virtual server (with the necessary storage) and a copy of Netbeans, Pspice, Visual Studio, Microwind, Prolog or MATLAB software running on it to use for homework or a class project. Likewise, a teacher could access the same cloud to request one virtual machine for each of his students running Math-media software or any other software, as part of his classroom instructional activities.

3.6 Proposed Educational Cloud Environment for Universities

Design of Cloud infrastructure needs the following services and application

3.6.1 Utility Services

Data-messaging services are included in primary utility services. This compels us to bring collaboration between private cloud and other managed service providers. It is believed that collaboration applications such as email, chatting, conferencing and collaborative file sharing solutions are a great fit for the cloud because they reduce costs in the short term[7]. In our choice Gmail apps or Facebook apps comes first as collaboration application, because it comes in handy without any charges.

3.6.2 Web Services

Moving existing web servers and cloud server to a central location will reduce maintenance costs. Cloud Server is the key part of the computing platform to ensure its scalability. All the resources can be stored at this cloud server which includes online videos, audios, pictures, and course wares etc. This web server infrastructure in cloud computing can share resources for educational and research purposes.

3.6.3 Data Recovery

Virtual resources need to be secured from any kind of risk, for example natural disaster. Like many companies and institutions we need to take measures for disaster recovery. The data on cloud must be taken as back-up off-site to the cloud to protect against natural disasters, IT mishaps, power outages and other unforeseen catastrophic events. We can also use other managed services to back-up our valuable data. Drop Box is a free service to take back up of our data in cloud environment. It enables synchronize with any device wherever drop box is installed. A cloud backup service can be enabled on university campus to safeguard students, staffs resources and also lecture data. This approach again needs some modification, addition and collaboration in our projected cloud.

3.6.4 Specialized Applications

The projected cloud will provide Software as Service to students and staffs of the academy. A list of all kinds of required software can be sorted out, both from students and staffs perspectives. Some examples are given here:

1. Coding
2. Word-processing and spreadsheet
3. Simulation
4. Designing
5. Networking
6. Multimedia and many more

Keeping these in view we implemented a cloud prototype during our research in a small scale and it worked satisfactorily. Here we installed MATLAB, Netbeans IDE, Codeblocks, Flex, Prolog, Pspice, Microwind, Skype, Microsoft Office, Media Player, Calculator, Paint and few other necessary software which could be accessed by all teachers and students using their individual id and passwords from their remote terminals.

Cloud is enriched with all necessary applications. Students, faculties and staffs can access these services remotely. This becomes more handy if it is accessed from mobile devices. For example, a smart phone using hosted mobile applications connects through carriers are also expected to gain access. Mobile phone is widely used among students, faculties and staffs. So customized application or service developed for university both can bring harmony and synchronization between them. A university mini Facebook would be a great deal to share and update news among the student, faculties and staffs.

3.7 Cloud Model for Academic Environment

Our research aims to suggest a cloud model for academic environment. Academic environment is where lots of computers are used at a time and many of them are not in use for

a longer period which lead to malfunction of computers. Maintenance of these computers is highly complicated due to lack of staff. The proposed cloud computing environment will be of storage infrastructure, development platform, and software delivering. Changing/updating of hardware/software resources and lots of storage capacity is required in academic environment computing lab. Many universities and colleges started using thin client technology to reduce the cost but thin client is not suitable for high performance computing.

Office applications, programming language, and multimedia developing courses are not only for IT department but for many other departments also. Every year, many new versions of applications are used for courses to meet the needs of industry. As a result new software causes new hardware costs. Installation and maintenance will be difficult from everyone. Whenever any new software appears many of hardware don't support and everyday many bytes of storage are required where loss of data is very high due to improper handling of computer by many students. At times students mistakenly or unknowingly delete important data.

These are the problems that are occuring due to decentralization of the computers' maintenances. If we do centralized control and decentralized execution through the use of cloud computing in universities then these maintenance would be more flexible.

By using cloud computing in academic environment, collaboration among the students, faculties and staffs will be more like using Google docs. Cloud Computing will be of immense useful by giving a virtual machine to everyone and a secure password to student and staff will work on their own virtual machine. If anything happens only the virtual machine will crash not the entire system. Below Figure represents the proposed cloud computing model for academic environment. Here faculties will focus their basic tasks and not lose their workforce. With this cloud computing environment student can work from their lab as well from home, where data and application will always be available.

3.8 Modeling and Simulating Application Server

We have implemented a prototype that uses remote desktop protocol. The server is enriched with all necessary applications required in a university - that is the application server. Users can access to our server remotely with the help of RDP. These two applications are running over oracle virtual box.

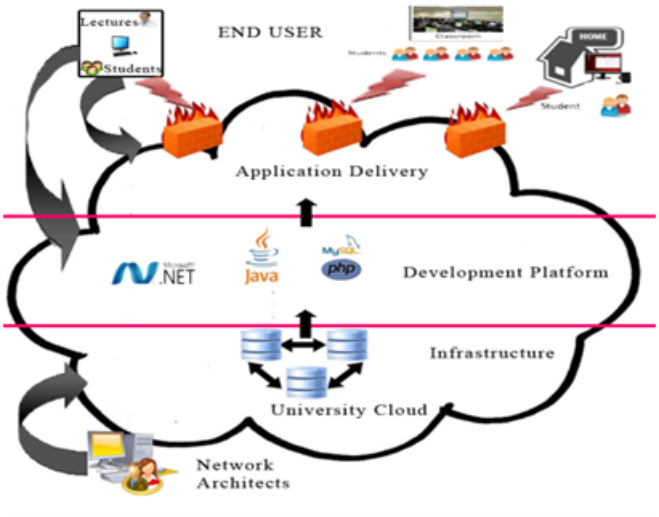

Figure 3.5: Cloud Structure

3.8.1 Virtual Box

Virtual Box is a powerful x86 and AMD64/Intel64 virtualization product for enterprise as well as home use. Virtual Box is not only an extremely feature rich, high performance product for enterprise customers, it is also the only professional solution that is freely available as Open Source Software under the terms of the GNU General Public License (GPL) version 2. Presently, Virtual Box runs on Windows, Linux, Macintosh, and Solaris hosts and supports a large number of guest operating systems but not limited to Windows (NT 4.0, 2000, XP, Server 2003, Vista, Windows 7, Windows 8), DOS/Windows 3.x, Linux (2.4, 2.6 and 3.x), Solaris and OpenSolaris, OS/2, and OpenBSD[8].

Figure 3.6: Virtual Box

Figure 3.7: Windows Server 2008

3.8.2 Windows Server 2008

Windows Server provides minimal server installation options for computers running on the Windows Server 2008 operating system or later. These options offer low-maintenance server environments with limited functionality. Windows Server installation options are designed for use by network and file service infrastructure developers, server management tool and utility developers, and IT Planners. Windows Server 2008 is built from the same code base as Windows Vista; therefore, it shares much of the same architecture and functionality. Since the code base is common, it automatically comes with most of the technical, security, management and administrative features new to Windows Vista such as the rewritten networking stack (native IPv6, native wireless, speed and security improvements); improved image-based installation, deployment and recovery; improved diagnostics, monitoring, event logging and reporting tools; new security features such as BitLocker and ASLR (address space layout randomization); improved Windows Firewall with secure default configuration; .NET Framework 3.0 technologies, specifically Windows Communication Foundation, Microsoft Message Queuing and Windows Workflow Foundation; and the core kernel, memory and file system improvements. Processors and memory devices are modeled as Plug and Play devices, to allow hot-plugging of these devices. This allows the system resources to be partitioned dynamically using Dynamic Hardware Partitioning; each partition has its own memory, processor and I/O host bridge devices independent of other partitions[9].

3.8.3 Remote Desktop Protocol (RDP)

RDP is a proprietary protocol developed by Microsoft, which provides a user with a graphical interface to connect to another computer over a network connection. The user employs RDP client software for this purpose, while the other computer must run RDP server soft-

ware. Clients exist for most versions of Microsoft Windows (including Windows Mobile), Linux, Unix, Mac OS X, iOS, Android, and other modern operating systems. RDP servers are built into Windows operating systems; an RDP server for Linux also exists. By default, the server listens on TCP port 3389[9][10].

CHAPTER 4

EXPERIMENTAL RESULT ANALYSIS

4.1 Work Plan

We began our objective to setup a Private Cloud environment for MIST. The most of usage of this cloud would be for academic purpose. In brief, we wanted to build a cloud infrastructure for MIST from where every single student and each faculty member could do his/her academic work very easily. We set the scope of our research work to apply this cloud environment for various laboratories of MIST.

In every computer lab, some specific software needs to be installed in each computer. Moreover they need to be updated time to time. It causes a number of difficulties. Such as each computer had to have high hardware configuration to support those software. But while one or two users are using that software, it needs not that much RAM/processor resource that is needed to support that software. As a result much of the resources are wasted.

If we can minimize these wastage, then this space can be utilized for other important purposes. If we run those software from a central server which is in cloud environment then this resource cost can be minimized. Here only the server will be of high hardware configuration and the users will use machines with the least configuration. The central server will be virtually partitioned for each user and the resources will be divided amongst the user as per their usage policy. As all the client machines are with least configuration so resources will be lessened and maintenance will be simpler.

4.2 Hardware Requirement

As we did our project in a small area, we did not work on a real server machine rather we managed a minimum requirement machine. Even though our machine can support all labs of CSE department simultaneously. The hardware configurations is mentioned below-

- AMD Processor
- 8 GB RAM (16 GB for best performance)
- High configuration motherboard for best speed

4.3 Problems with Hardware and Operating System

When we got our machine with required configuration, we wanted to partition the machine virtually. And for that we wanted to install VMware. But while installing it was not getting the LAN port and stopping installation. We changed the motherboard and tried a number of different combinations of processors, motherboard and RAM. But we could not be succeeded. Then we tried to install Openstack (another virtualizing OS). It is needed to be installed on Linux kernel. But, for Linux, when we tried to install Ubuntu 9.4 it was not installing. These are the problems that we faced during configuration of MIST private cloud.

4.4 Final Setup

After that we decided to do our work on Windows server. We installed Windows 7 and installed Virtual Box there. In the Virtual Box we installed two different OS. One is Windows server 2008 RD, and another is a AD server which is also from Windows. Here the AD server is working something like a default proxy server for both the RD server and the physical machine. AD server is being used for all types of user authentication and machine authentication. On the other hand, in RD server we installed all the software that is used in labs.

In addition we have installed a file server where necessary softwares, lectures and other required documents will be kept stored for the use by students. Students can download those in their own desktop, i.e. in their physical machine.

4.5 Limitations

Cloud Computing has emerged as a new brand of computing. There are not much text books available on this subject. Also there is scarcity of research papers in this field. Thus we experienced shortage of study materials and resources. Due to shortage of time and resource

we could not implement our project entirely covering the university campus. But from empirical study we can ensure that our proposed approach will meet the goal successfully. Another limitation of our work is in selection of the requirement of different universities according to their subject curriculum. As different universities will have different goal and purposes, the requirement and cost orientation for prioritization can be different. As we have used Remote Desktop Protocol developed by Microsoft, we need Windows platform to implement this proposed project. Another limitation is we obviously need to use updated Internet Explorer.

CHAPTER 5

CONCLUSION AND FUTURE EXPANSION

5.1 Vast Area of Cloud

Cloud Computing can be defined as providing resources and capabilities of Information Technology (e.g., applications, storages, communication, collaboration, infrastructure) via services offered by cloud computing providers. Cloud Computing has various characteristics as shared infrastructure, self-service, pay-peruse model, dynamic and virtualized, elastic and scalable. Nowadays, because of the increasing popularity of Cloud Computing many giant IT companies such as Microsoft, IBM, Google and Amazon interest developing new cloud environments due to advantages of the Cloud Computing technology include cost, availability, and scalability. A Cloud Computing service has ubiquitous access through a Web browser or mobile device with APIs or special desktop applications developed by cloud service provider. Use of Cloud Computing on universities has many benefits such as accessing the file storages, e-mails, databases, educational resources, research applications and tools anywhere for faculty, administrators, staffs, students and other users in university, on demand. Furthermore, cloud computing reduces universities' IT complexity and cost.

5.2 Cloud and its Future

Rapid decrease in hardware cost and increase in computing power and storage capacity are the main factor of cloud computing. The exponentially growing data size in scientific instrumentation, simulation, internet publishing and archiving bring the necessity of cloud computing in the forward. The Cloud Computing trend of replacing software traditionally installed on campus computers with applications delivered via the internet is driven by aims of reducing universities' IT complexity and cost. Cloud Computing could be a technological innovation that reduces IT costs for the institutes and eliminates many of the time-related constraints for students, making learning tools accessible for a larger number of students.

With cloud computing, universities can open their technology infrastructures to businesses and industries for research advancements. The efficiencies of cloud computing can help universities keep pace with ever-growing resource requirements and energy costs. It enables institutions to teach students in new, innovative ways and help them manage projects and massive workloads. When students enter the global workplace they will better understand the value of new technologies. It allows students and teachers to use applications without installing them on their computers and also allows access to saved files from any computer with an internet connection.

5.3 Achievement of Our Work

Cloud Computing paradigm is a new approach to produce a solution for old problems. This paradigm offers many benefits to enterprises, industries and universities. Many large IT companies develop new cloud-based applications and construct new cloud infrastructure. Most of the research literature focused on benefits, opportunities, advantages, disadvantages, risks and configuration of Cloud computing for enterprises. In this paper and in our suggested model we have tried to show that the Cloud Computing can also be used for universities. We developed a cost effective model where we have installed a good number of required software for a technology based university. We tested our job using different users (Teacher, Student and Admin). We found that use of Cloud Computing on universities has many benefits such as accessing the file storages, e-mails, video conference, databases, educational resources, research applications, programming software, language software and tools anywhere for faculty, administrators, staff, students and other users in university on demand. The main goal of suggested model is; managing effectively the technological needs of universities such as delivery of software, providing development platform, storage of data and computing.

5.4 Scope for Future Work

In future research, we propose to perform an experimental study on larger models that can be useful for all types of universities be it technological, researchers or literature. Thereby enough scopes will be there to have better understanding about the advantages and limitations of our proposed system.

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