A Project Report
on

IMPLEMENTATION OF PRIVATE CLOUD

Submitted in partial fulfillment of the requirements for the Major Project II of

Bachelor of Technology
in
Computer Science & Engineering

Submitted by:

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CERTIFICATE

This is to certify that the Project entitled **"Implementation of private cloud"**submitted by

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for the partial fulfillment of the requirements of the course **Major Project II** of **Bachelor of Technology in Computer Science & Engineering** degree of **University of Petroleum & Energy Studies, Dehradun**embodies the confide work done by above students under my supervision.

Signature of Mentor
Designation

DECLARATION

We, Ravi Joshi and Siddhant Rajput bearing the Roll No: R780209024 and R780209033respectively hereby declare that this Project work entitled "Project Title" was carried out by us under the guidance and supervision of Dr. Ajay Shankar Singh. This Project work is submitted to University of Petroleum & Energy Studies in partial fulfilment of the requirement for the award of Bachelor of Technology in Computer Science and Engineering during the Academic Semester Jan 2013 – April 2012. We also declare that, we have not submitted this dissertation work to any other university for the award of either degree or diploma.

Ravi Joshi

Place: Dehradun

Siddhant Rajput

Date: 25/4/2013

ABSTRACT

Cloud computing has emerged as a viable model for scalable data center capacity, automation and reduced infrastructure costs. But challenges have emerged as well. Many objectors focus on performance and security as well as fears about IT roles and losing control of the data center reins. Private clouds have also received some criticism, including a lack of application suitability and problematic support.

Crowbar is an open source software framework developed by Dell. With Crowbar, you can install cloud software across clusters and scale out systems quickly and automatically. Crowbar also provides capabilities for network monitoring and discovery, and gathering performance data, among other advantages. With Crowbar, you have a configurable, adjustable framework complete with many built-in features that can save time, streamline effort and potentially lower costs.

OpenStack is an open and scalable operating system for building public and private clouds. It provides both large and small organizations an alternative to closed cloud environments, reducing the risks of lock-in associated with proprietary platforms. OpenStack offers flexibility

ACKNOWLEDGEMENT

It is a pleasure to thank all thosegreat many people who helped, supported and encouraged us during this project work.

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Ravi Joshi (R780209024)

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CHAPTER 1 INTRODUCTION

1.1 What is private cloud?

Private cloud is cloud infrastructure operated solely for a single organization, whether managed internally or by a third-party and hosted internally or externally.[4] Undertaking a private cloud project requires a significant level and degree of engagement to virtualize the business environment, and requires the organization to reevaluate decisions about existing resources. When done right, it can have improve business, but every step in the project raises security issues that must be addressed to prevent serious vulnerabilities.

Cloud Computing has evolved to a mature state and offers distinct cost saving opportunities by consolidating and restructuring information technology services. The Federal government has developed policies and directives that mandate migration to cloud computing solutions as a means of reducing information technology infrastructure service costs. Departments and Agencies must ensure their information security and privacy requirements are met, given the risks posed by cloud computing solutions. Many state and local governments are seeking cloud solutions.

A private cloud is a new model for IT delivery. It transforms datacenter resources to enable the key benefits of cloud computing. By creating a layer of abstraction over pooled resources, a private cloud enables true service capability as well as optimally managed application services

It is a cloud computing platform built on your own hardware and software. The alternative is to deploy the services you need on a public cloud infrastructure provided by an external supplier such as Amazon Web Services, Rackspace Cloud or HP Public Cloud. While a public cloud can afford greater flexibility, with all resource delivered as a service and billed by the hour, a private cloud gives you the advantage of greater control over the entire stack, from the bare metal up to the services accessible to users.

In contrast to public cloud computing, a private cloud is typically hosted within a company's firewalls. Alternately, some companies host their private cloud with an external third party provider, which allows these deployments to tap into external compute resources on an on-demand basis.

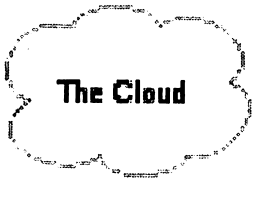
Imagine yourself in the world where the users of the computer of today's internet world don't have to run, install or store their application or data on their own computers, imagine the world where every piece of your information or data would reside on the Cloud (Internet).

As a metaphor for the Internet, "the cloud" is a familiar cliché, but when combined with "computing", the meaning gets bigger and fuzzier. Some analysts and vendors define cloud computing narrowly as an updated version of utility computing: basically virtual servers available over the Internet.

Others go very broad, arguing anything you consume outside the firewall is "in the cloud", including conventional outsourcing.

Cloud computing comes into focus only when you think about what we always need: a way to increase capacity or add capabilities on the fly without investing in new infrastructure, training new personnel, or licensing new software. Cloud computing encompasses any subscription-based or pay-per-use service that, in real time over the Internet, extends ICT's existing capabilities.

Cloud computing is at an early stage, with a motley crew of providers large and small delivering a slew of cloud-based services, from full-blown applications to storage services to spam filtering. Yes, utility-style infrastructure providers are part of the mix, but so are SaaS (software as a service) providers such as Salesforce.com. Today, for the most part, IT must plug into cloud-based services individually, but cloud computing aggregators and integrators are already emerging.

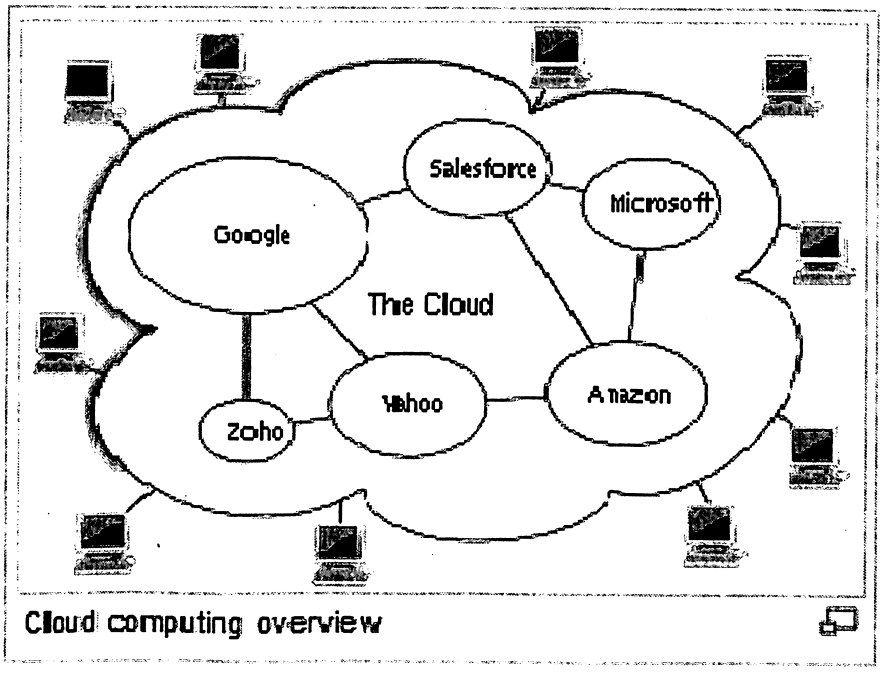


1.2 Cloud computing- The Concept

Cloud computing is Internet ("cloud") based development and use of computer technology ("computing"). It is a style of computing in which dynamically scalable and often virtualized resources are provided as a service over the Internet. Users need not have knowledge of, expertise in, or control over the technology infrastructure "in the cloud" that supports them.

The concept incorporates infrastructure as a service **(IaaS)**, platform as a service **(PaaS)** and software as a service **(SaaS)** as well as Web 2.0 and other recent technology trends which have the common theme of reliance on the Internet for satisfying the computing needs of the users. Examples of SaaS vendors include Salesforce.com and Google Apps which provide common business applications online that are accessed from a web browser, while the software and data are stored on the servers.

The term ***cloud*** is used as a metaphor for the Internet, based on how the Internet is depicted in computer network diagrams, and is an abstraction for the complex infrastructure it conceals.



Cloud computing overview

Private cloud is cloud infrastructure operated solely for a single organization, whether managed internally or by a third-party and hosted internally or externally.

Pooled Resources:

In a private cloud, key hardware resources—compute, storage, and networking—are pooled and abstracted into units that enables to dynamically provision and scale applications and resources.

Self-service:

Deliver applications and resources as services. Your customers can request, configure, and manage IT services through an interactive portal that allows for automated provisioning.

Elastic:

Resources can quickly be expanded or contracted through automation or work flow, so IT services can be scaled up or down almost instantly to meet business requirements.

Usage-based:

With resources as services, usage can be metered so that customers pay for only the resources that are actually consumed.

Private clouds has following advantages

Significant Cost Reduction

As discussed in section 1 the cost of implementing the Egovernance is very high but in cloud computing available at a fraction of the cost of traditional IT services; upfront capital expenditures eliminated; dramatically reduced IT administrative burden

Increased Flexibility

On-demand computing across technologies, business solutions and large ecosystems of providers; reduced new solution implementation times.

Access anywhere:

The services will accessed from a single computer or network.Use different computer or move to portable devices, and applications and documents follow.

Elastic scalability and pay-as-you-go

Add and subtract capacity as your needs change. Pay for only what you use.

Easy to implement

No need to purchase hardware, software licenses or implementation services.

Service quality

Reliable services, large storage and computing capacity, and 24X7 service and up-time.

Delegate non-critical applications

Outsource non-critical applications to service providers and focus agency ITresources on business-critical applications.

Always the latest software

Updates are automatic in cloud computing.

Private Public Partnership

Applications and documents accessible from anywhere in the world, facilitating group collaboration on documents and projects.

1.3 Why Private Cloud?

The reasons for using a private cloud are cost reduction, enhancing service quality, and, more importantly, reducing the time it takes to deliver what users demand.
Cost savings are driven by standardization or automation of services or IT computer resources. Standardization and automation reduce operational costs and free IT personnel to focus more on servicing customers than on activities with little or no added value, such as allocating disk space or configuring software. It is absolutely crucial for the quality of cloud services delivered by IT to be superior to the current model.

Cost Efficient
Cloud computing is probably the most cost efficient method to use, maintain and upgrade. Traditional desktop software costs companies a lot in terms of finance. Adding up the licensing fees for multiple users can prove to be very expensive for the establishment concerned. The cloud, on the other hand, is available at much cheaper rates and hence, can significantly lower the company's IT expenses. Besides, there are many one-time-payment, pay-as-you-go and other scalable options available, which makes it very reasonable for the company in question.

Almost Unlimited Storage
Storing information in the cloud gives you almost unlimited storage capacity. Hence, you no more need to worry about running out of storage space or increasing your current storage space availability.

Backup and Recovery
Since all your data is stored in the cloud, backing it up and restoring the same is relatively much easier than storing the same on a physical device. Furthermore, most cloud service providers are usually competent enough to handle recovery of information. Hence, this makes the entire process of backup and recovery much simpler than other traditional methods of data storage.

Automatic Software Integration
In the cloud, software integration is usually something that occurs automatically. This means that you do not need to take additional efforts to customize and integrate your applications as per your preferences. This aspect usually takes care of itself. Not only that, cloud computing allows you to customize your options with great ease. Hence, you can handpick just those services and software applications that you think will best suit your particular enterprise.

Easy Access to Information
Once you register yourself in the cloud, you can access the information from anywhere, where there is an Internet connection. This convenient feature lets you move beyond time zone and geographic location issues.

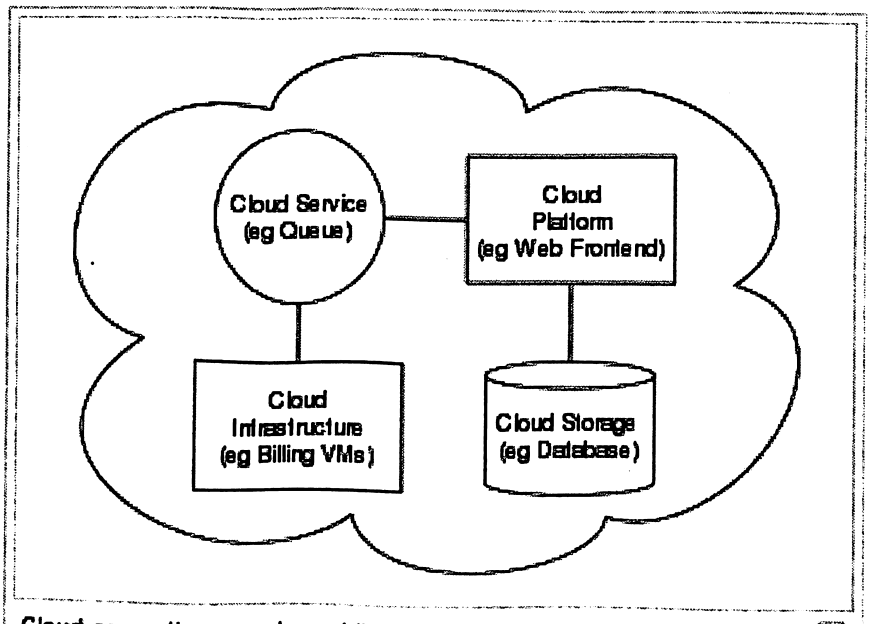
1.4 Architecture

Cloud architecture, the systems architecture of the software systems involved in the delivery of cloud computing, comprises hardware and software designed by a cloud architect who typically works for a cloud integrator. It typically involves multiple cloud components communicating with each other over application programming interfaces, usually web services.

This closely resembles the UNIX philosophy of having multiple programs doing one thing well and working together over universal interfaces. Complexity is controlled and the resulting systems are more manageable than their monolithic counterparts.

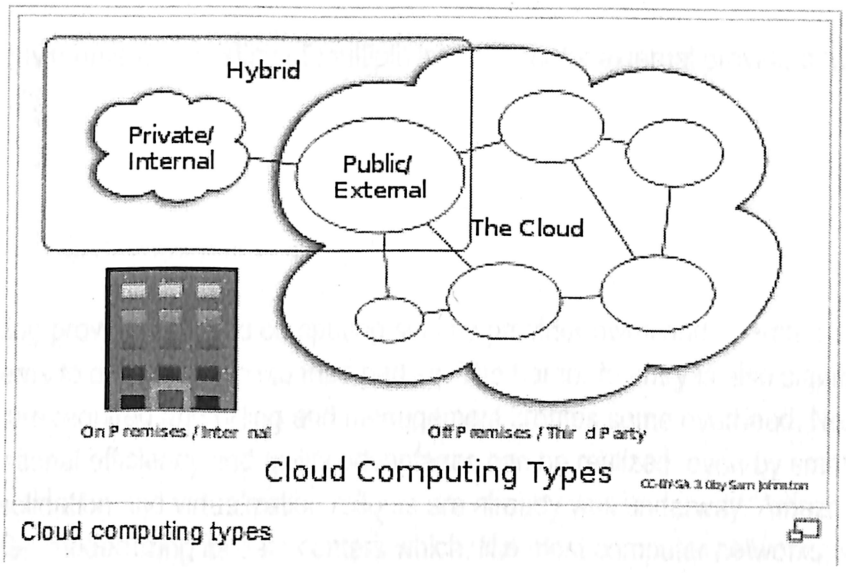
Cloud architecture extends to the client, where web browsers and/or software applications access cloud applications.

Cloud storage architecture is loosely coupled, where metadata operations are centralized enabling the data nodes to scale into the hundreds, each independently delivering data to applications or user.



Cloud computing sample architecture

1.5 Types of Clouds



Cloud computing types

Public cloud

Public cloud or *external cloud* describes cloud computing in the traditional mainstream sense, whereby resources are dynamically provisioned on a fine-grained, self-service basis over the Internet, via web applications/web services, from an off-site third-party provider who shares resources and bills on a fine-grained utility computing basis.

Private cloud

Private cloud and *internal cloud* are neologisms that some vendors have recently used to describe offerings that emulate cloud computing on private networks. These products claim to "deliver some benefits of cloud computing without the pitfalls", capitalizing on data security, corporate governance, and reliability concerns.

While an analyst predicted in 2008 that private cloud networks would be the future of corporate IT, there is some uncertainty whether they are a reality even within the same firm. Analysts also claim that within five years a "huge percentage" of small and medium enterprises will get most of their computing resources from external cloud computing providers as they "will not have economies of scale to make it worth staying in the IT business" or be able to afford private clouds.

The term has also been used in the logical rather than physical sense, for example in reference to platform as service offerings, though such offerings including Microsoft's Azure Services Platform are not available for on-premises deployment.

Hybrid cloud

A *hybrid cloud* environment consisting of multiple internal and/or external providers "will be typical for most enterprises".

1.6 Roles

Provider

A cloud computing provider or cloud computing service provider owns and operates live cloud computing systems to deliver service to third parties. The barrier to entry is also significantly higher with capital expenditure required and billing and management creates some overhead. Nonetheless, significant operational efficiency and agility advantages can be realized, even by small organizations, and server consolidation and virtualization rollouts are already well underway. Amazon.com was the first such provider, modernizing its data centers which, like most computer networks, were using as little as 10% of its capacity at any one time just to leave room for occasional spikes. This allowed small, fast-moving groups to add new features faster and easier, and they went on to open it up to outsiders as Amazon Web Services in 2002 on a utility computing basis.

1.7 Some case studies

Scenario 1

High availability

If hardware fails, server is automatically booted on a remaining node

Scenario 2

Add server

Add server in a matter of minute. To handle a peak period add a webserver easily by cloning it.

Scenario 3

Hardware Independence

Virtualization is always the same. No need of reinstallation when changing hardware.

CHAPTER 2 PROBLEM DEFINITION

Development and testing expenditure accounts for a significant portion of annual IT budgets. Improvements and efficiencies achieved in this area will result in a decrease in overall costs while also reducing production outages. With the growing complexity of applications, there is an ongoing need to test often and to test as efficiently as possible. This is especially true for custom software development (software languages, application servers, application architecture, or testing issues), which, on average, accounts for 25% of an IT department's software budget.[1]

Cloud computing entrusts remote services with a user's data, software and computation.

End users access cloud-based applications through a web browser or a light-weight desktop or mobile app while thebusiness software and user's data are stored on servers at a remote location. Proponents claim that cloud computing allows companies to avoid upfront infrastructure costs, and focus on projects that differentiate their businesses instead of infrastructure.[1] Proponents also claim that cloud computing allows enterprises to get their applications up and running faster, with improved manageability and less maintenance, and enables IT to more rapidly adjust resources to meet fluctuating and unpredictable business demand.[1][2][3]

In the business model using software as a service, users are provided access to application software and databases. Cloud providers manage the infrastructure and platforms that run the applications. SaaS is sometimes referred to as "on-demand software" and is usually priced on a pay-per-use basis. SaaS providers generally price applications using a subscription fee.

CHAPTER 3 LITERATURE SURVEY

3.1 Private cloud Service

3.1.1 Infrastructure as a Service (IaaS):

The consumer uses "fundamental computing resources" such as processing power, storage, networking components or middleware. The consumer can control the operating system, storage, deployed applications and possibly networking components such as firewalls and load balancers, but not the cloud infrastructure beneath them. The capability provided to the consumer is to provision processing, storage, networks,and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems; storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).

In this most basic cloud service model, cloud providers offer computers, as physical or more often as virtual machines, and other resources. The virtual machines are run as guests by a hypervisor, such as Xen or KVM. Management of pools of hypervisors by the cloud operational support system leads to the ability to scale to support a large number of virtual machines. Other resources in IaaS clouds include images in a virtual machine image library, raw (block) and file-based storage, firewalls, load balancers, IP addresses, virtual local area networks (VLANs), and software bundles.

Examples of IaaS include: Amazon CloudFormation (and underlying services such as Amazon EC2), Rackspace Cloud, Terremark and Google Compute Engine.

3.1.2 Platform as a Service (PaaS):

The consumer uses a hosting environment for their applications. The consumer controls the applications that run in the environment (and possibly has some control over the hosting environment), but does not control the operating system, hardware or network. infrastructure on which they are running. The platform is typically an application framework. The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported 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 application hostingenvironment configurations.

In the PaaS model, cloud providers deliver a computing platform typically including operating system, programming language execution environment, database, and web server. Application developers can develop and run their software solutions on a cloud platform without the cost and complexity of buying and managing the underlying hardware and software layers. With some PaaS offers, the underlying computer and storage

resources scale automatically to match application demand such that cloud user does not have to allocate resources manually.

Examples of PaaS include: Amazon Elastic Beanstalk, Cloud Foundry, Heroku, Force.com, EngineYard, Mendix, Google App Engine, Microsoft Azure and OrangeScope.

3.1.3 Software as a Service (SaaS):

The consumer uses an application, but does not control the operating system, hardware or network infrastructure on which it's running. The capability provided to the consumer is to use the provider's applications 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 email). 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 settings

In this model, cloud providers install and operate application software in the cloud and cloud users access the software from cloud clients. The cloud users do not manage the cloud infrastructure and platform on which the application is running. This eliminates the need to install and run the application on the cloud user's own computers simplifying maintenance and support. What makes a cloud application different from other applications is its elasticity. This can be achieved by cloning tasks onto multiple virtual machines at run-time to meet the changing work demand. Load balancers distribute the work over the set of virtual machines. This process is inconspicuous to the cloud user who sees only a single access point. To accommodate a large number of cloud users, cloud applications can be multitenant, that is, any machine serves more than one cloud user organization. It is common to refer to special types of cloud based application software with a similar naming convention: desktop as a service, business process as a service, test environment as a service, communication as a service.

Examples of SaaS include: Google Apps, innkeypos, Quickbooks Online, Limelight Video Platform, Salesforce.com and Microsoft Office 365.

3.2 Crowbar

Crowbar was originally developed by the Dell CloudEdge Solutions Team as an OpenStack installer, but has since evolved to be an open-source general purpose tool. It is a platform for server provisioning and deployment from bare metal, providing server discovery, firmware upgrades, and operating system installation using PXE Boot. It can also deploy applications on top of functioning operating systems with opscode Chef."

- Crowbar is a Linux provisioning server that facilitates and automates the network-based installation of multiple computer operating systems from a central point using services such as DHCP, TFTP, and DNS along with the openstack stack.

- It can be configured for PXE, reinstallations,and virtualized guests using Xen, KVM or VMware.
- Crowbar interacts with the native installer anaconda (software)/ Ubuntu installer -> Ubiquity for re-installation and virtualization support. Crowbar use libvirt to integrate with different virtualization software. Crowbar is able to manage complex network scenarios like bridging on a bonded Ethernet link.

3.3 Ways to access Private Cloud

- Assign an Elastic IP Address
- Sign up to open stack
- Copy, write, read, access data

CHAPTER 4 SYSTEM REQUIREMENT SPECIFICATION

4.1 Hardware and Software Required

Hardware:

- **Controller Node:**
  - ✓ Server with Quad core Intel or AMD processor.
  - ✓ 8 GB RAM
  - ✓ High bandwidth Internet connection
  - ✓ 2 Network Interface Cards.
- **Compute Nodes:**
  - ✓ 64-bit enabled node.
  - ✓ 16 GB RAM.
  - ✓ 1 Network Interface Card.

Software:

- **Operating System:**

  The operating system to be used will be Ubuntu Server 12.04. Ubuntu is a Debian based OS, which itself is a community based free operating system. Ubuntu 12.04 is Long-Term-Support release i.e. it will get support for 5 years.
- **OpenStack:**

  OpenStack is an Infrastructure as a Service (IaaS) cloud computing project started by Rackspace Cloud and NASA in 2010. Currently more than 150 companies have joined the project among which are AMD, Intel, Canonical, SUSE Linux, Red Hat, Cisco, Dell, HP, IBM and Yahoo!. It is free open source software released under the terms of the Apache License.
- **Crowbar.**
- **OFED (Open Fabrics Enterprise Distribution).**
- **MVAPICH.**
- **HPL (High Performance LINPACK).**

CHAPTER 5 SYSTEM DESIGN

Cloud computing architecture refers to the components and subcomponents required for cloud computing. These components typically consist of a front end platform (fat client, thin client, mobile device), back end platforms (servers, storage), a cloud based delivery, and a network (Internet, Intranet, Intercloud). Combined, these components make up cloud computing architecture.

Generally, the cloud network layer should offer:

- **High bandwidth (low latency)**
  Allowing users to have uninterrupted access to their data and applications.

- **Agile network**
  On-demand access to resources requires the ability to move quickly and efficiently between servers and possibly even clouds.

- **Network security**
  Security is always important, but when you are dealing with multi-tenancy, it becomes much more important because you're dealing with segregating multiple customers.

We've designed SoftLayer Private Clouds so that you can deploy an entire private cloud at the push of a button—when and where you want it, ready for whatever you want to do with it.

We've automated the provisioning and configuration of all the infrastructure for a full private cloud solution—including servers, networking, and virtualization software. It's all built on our global cloud infrastructure built for Internet scale, which seamlessly spans our worldwide data center and network footprint.

CHAPTER 6 IMPLEMENTATION

6.1 Controller node installation:

1. Arrange the hardware according to requirement.
2. Insert crowbar with Ubuntu media and boot the controller from it.
3. After installation is done, run install script present in /tftpdboot/ubuntu_dvd/extra. This script will deploy crowbar in your controller node.
4. For checking or validating the crowbar installation, go to http://192.168.124.10:3000/ or http://<ipadr of controller>:3000/ on monitor node. This link will bring up the crowbar web UI which is very user friendly.

6.2 Compute nodes installation:

1. Do PXE boot from compute nodes.
2. While PXE boot, compute nodes will get in to discovered state. You can check the presence of compute nodes in crowbar UI.
3. Create a Barclamp for compute node. Installation of compute node will be finished in few minutes.

6.3 MVAPICH and HPL compilation:

1. Install MVAPICH1 on each node.
2. Create a NFS share and a user sharing common key file across the nodes (i.e. user should not ask for password while doing ssh across the setup).
3. Compile HPL in NFS share by common user with proper edit in makefile (i.e. with MVAPICH compilers).
4. Run xhpl.

CHAPTER 7 CONCLUSION

Cloud Computing is an internet computing model where data is stored on servers that are on the Internet and temporarily cached on the clients' computing devices such as: desktop computers, laptops, hand-held mobile devices, etc. Cloud computing involves the supply of on-demand IT computing functions and utilities that are delivered from third party platforms as a service. On-demand services and components include: software-as-a-service, platform-as-a-service, and storage-as-a-service.

The system architecture of cloud computing system consists of two parts - the front end and the back end. A network such as the internet will connect the two parts to each other. The front end is the section that is viewed by the user and includes the application that allows the user to gain access to the cloud environment. The back end is the cloud part. In the back end, there are an assortment of computers, servers, and data storage systems that all work to create the "cloud."

The user interface will vary for the cloud computing systems. For instance, there are cloud systems that have distinct applications to allow users to network access and there are services such as web-based e-mail programs that allow access through web browsers. A central server administers the system to make sure everything is running efficiently. As well, with cloud computing, a copy of all the user's information is created and stored on other devices which enables an effective backup and restore system. This is known as redundancy.

The concept of cloud computing comes from the network diagrams illustrating the Internet as a cloud, where it is not possible, or not important, to know the information path. While the main reasons for adopting services based on cloud computing are cost saving, flexibility and start-up speed, there are still doubts about the security guarantees and the portability and integration options offered by this model of services. The services offered in any of the cloud computing models (platform, infrastructure or software as a service) are closely related to mobility and, therefore, depend heavily on the continuity of the connectivity, the quality of the service and the security offered by the networks for an optimal user experience. Cloud computing provides companies with new options for managing infrastructures and new business models. In particular, it can mean a big improvement for small and medium-size companies, for whom the cloud represents the opportunity to reduce costs in administration and in maintaining proprietary infrastructures, providing them with technological possibilities similar to those of large companies. Doubts over the security and management of these new systems, however, may slow the uptake in the short term.

CHAPTER 8 FUTURE ENHANCEMENTS

With arrival of cloud computing the conventional way of computing has gone for a sea change. And this new addition in the computing is not a flash in the pan as it is going to rule the roost in the future. As per some expert opinions, it is going to be the face of future cloud computing. And hence, the future of cloud computing seems very promising.

As per some surveys conducted by leading organizations, 70% of Americans will be getting benefited from cloud and it various applications in next decades for official and personal use. And this is not an overestimate or exaggeration, as we are already using cloud and its applications in one form or another. Using email and connecting to social media through smart phones, watching movies over smart phones and uploading and accessing pictures from websites like Flicker are common examples of cloud computing in our day-to-day life.

Let us have a look on what makes the future of cloud computing so bright.

1. **Presence of Internet will boost its future**:

   The cloud computing will becomes all the more important with the omnipresence of high-speed, broadband Internet. Slowly but steadily we are getting closer. Even airlines are offering satellite based wi-fi services in flights. In a mass drive to connect every village with Internet wireless Internet services are offered through the help of satellite, although speed is a bit slow. This increasing presence of Internet is opening new vistas in educations and healthcare. With the help of cloud computing we can use these services at a little cost.

2. **No more software updates:**

   Most of the computer professionals loose lots of their time and efforts downloading different versions of software so that they can access the various programs and data with little efforts. Most of the softwares are on the cloud servers so you don't need to down and install for little use. So, whether you want to access emails or go through spreadsheet, it has become fun with the arrival of cloud computing. As per some estimates a sizable number of softwares will be delivered through the Internet.

3. **Hardware optional:**

   With the arrival of cloud computing it is no longer necessary to purchase hard drives with large storage capacity, as it can be stored on cloud. So keep the fear of loosing your data away. All your data with complete back up can be stored on the cloud. So with rising popularity the computers will act as an interface to communicate with cloud Computing.

4. **Entertainment unlimited:**

   As hardware is no more mandatory, so there is no limit on entertainment options. Uploading latest software and buying games from the market is going to be things of the past. In the future, there will be mobile 3D games to entertain your kids.

5. **Medical treatments simplified**:

   The future of cloud computing is not confined to entertainment and gaming options as it can contribute massively in the fields of medical sciences as well. As most of the contemporary treatment require computer assistance, as data have to be searched for various things like DNA samples and other biochemical procedures and hence cloud computing is going to play its part in the most of the therapies. In addition, it will make easy the task of data processing.

6. **Weather Forecasting**:

   It is believed that with increased level of computing coupled with improved climate models it will be lot more easy makes weather forecasts.

7. **Education for all**:

   With lot of educational institutions offering free course material for everyone over the Internet it is here cloud computing can play a great role delivering education on the doorsteps of learners over an interface. In addition, it will be a giant leap towards digitalization of education. So what if you have not secured admission at a reputed university, you can learn various things over computer with Internet connection.

8. **Freedom from Wallets:**

   With the advent of mobile phones the concept of traditional wallets has gone for toss. Now everything right from your contact details to your shopping related needs and you air ticket for vacations to clicking the pictures of happy moments, everything can be done by you smart phone. The cloud has made it possible. It is possible in the futures that you can store all you valuable documents like driving license and voter identity with the help of your smart phone.

9. **Paperless society? Yes, it is possible.**:

   You have seen pile of wastepaper in the offices or dustbins full of torn paper. Now these things are going to change. There is no need to cut trees for making paper as we can do most of the transactions and communications online. And cloud computing has certainly a role to play here.

Now we can book mobile tickets for concerts and moving, as most of these things are available on the cloud.

10. **No need to rub shoulders**:

If going to a grocery store irritates you, as it is crowded don't go there. Just get to the Internet and add things to the cart and order. The product will be delivered at your doorstep. Nowadays the shopping has gone online and cloud computing has certain role to play in the business.

11. **Get your location**:

The location services offered by some social networking sites like twitter in US and Foursquare assist helps people to locate their family and friends. With the help of cloud computing, the locations services are going to be better for sure. Now it can be used in rescuing operations to finding the location of the victims.

12. **A boon to Digital media**:

Arrival of cloud could be a boon for the digital media. Now independent artists and creative writer can reach to more and more peoples and thus ending the monopoly of certain media organizations. The rising competition will open the floodgates of the creative writers and digital media content providers. If all the content is not for free the users can at least find out from where to by this music or a book and thus saving their lot of time and efforts. In the coming years, buying DVD from a market and endless cue at a cinema hall is going to be obsolete.

13. **Cloud Computing: The New Age lifesaver**:

It may appears ridiculous and exaggerated to many but with the arrival of computing one can store the medical records on cloud in a single digital repository and one can access it from the any part of the world. And you don't have to lament that you have left you all medical records behind. Do you think it is possible to ECG, X-rays and blood test report while you are heading for a vacation? Enjoy your life on the vacation and in the case of some medical emergency you can access it by pressing some keys on keyboard and clicking the mouse.

14. **A new age safety system:**

With the help of cloud computing, records of cars including number. Driving license and address detail of the owner can be stored on the cloud in case the car is stolen one and recovered by some security agency in far off locations, they can instantly inform the owner of the car. It also lessens the burden of the various police and security organizations in a given region. Like wise complete details of all the population of a county that including Fingerprint

and DNA records can be given. It will help recruiters in doing background checks before giving employment to candidates. It will help reduces theft and misconduct in some cases.

15. **An efficient tool in disaster management:**

With improved location services the disaster management team find it easy to help the victims in the time of emergency. As we all know the golden hour is wasted in finding the locations of the victims. This facility will prove a boon in helping those in the need. Most of the times, when an aircraft meets an accident, it is hard to find the location of the wreckage of the aircraft. The cloud computing in conjunction to Satellite and aerial imagery can help find the location in a very short span of time and thus saving lot of time and effort of manual search done by security agencies.

16. **Now everyone is entrepreneur**:

With arrival of cloud anyone can turn entrepreneur. It provides easy solution to various IT problems faced by of new startups. For example if you have a particular skill on display you can give it on cloud and likewise the artist can give samples of their art on YouTube, where they can find numerous potential takers for their skill.

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APPENDIX – SAMPLE SCREEN PRINTS