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CLOUD COMPUTING

GOUTAM BHATTA
G.L Choudhury College, Barpeta Road, Assam, India

ABSTRACT

Cloud computing is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid. Cloud computing is a paradigm shift following the shift from mainframe to client–server in the early 1980s. Details are abstracted from the users, who no longer have need for expertise in, or control over, the technology infrastructure "in the cloud" that supports them. 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.

KEYWORDS: Cloud Computing is Internet-Based Computing

INTRODUCTION

Cloud Computing Basics

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.

Types of Cloud

- **Public Cloud**

  In this type an organization rents cloud services from cloud providers demand basis. 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 and bills on a fine-grained utility computing basis. Services provided to the users using utility computing model.

- **Private Cloud**

This type of cloud is maintained within an organization and used solely for their internal purpose. Private cloud or internal clouds have been described as neologisms; however the concepts themselves pre-date the term cloud by 40 years. Even within modern utility industries, hybrid models still exist despite the formation of reasonably well functioning markets and the ability to combine multiple providers. The idea was based upon direct comparison with other industries (e.g. the electricity industry) and the extensive use of hybrid supply models to balance and mitigate risks. Many companies are moving towards this setting and experts consider this is the 1st step for an organization to move into cloud. Security, network bandwidth are not critical issues for private cloud.

- **Hybrid Cloud**

This type of cloud is composed of multiple internal or external cloud. Hybrid cloud environment consisting of multiple internal and/or external providers" will be typical for most enterprises". By integrating multiple cloud services users may be able to ease the transition to public cloud services while avoiding issues such as PCI compliance. Another perspective on deploying a web application in the cloud is using Hybrid Web Hosting, where the hosting infrastructure is a mix between Cloud Hosting for the web server, and Managed dedicated server for the database server.

Key Characteristics of Cloud Computing

- **Cost** is greatly reduced and capital expenditure is converted to operational expenditure. This lowers barriers to entry, as infrastructure is typically provided by a third-party and does not need to be purchased for one-time or infrequent intensive computing tasks. Pricing on a utility computing basis is fine-grained with usage-based options and minimal or no IT skills are required for implementation.
- **Device And Location Independence** enable users to access systems using a web browser regardless of their location or what device they are using, e.g., PC, mobile. As infrastructure is off-site (typically provided by a third-party) and accessed via the Internet the users can connect from anywhere.
- **Multi-Tenancy** enables sharing of resources and costs among a large pool of users, allowing for:
    - **Centralization** of infrastructure in areas with lower costs (such as real estate, electricity, etc.)
    - **Peak-load capacity** increases (users need not engineer for highest possible load-levels)
    - **Utilization and efficiency** improvements for systems that are often only 10-20% utilized.
- **Reliability** improves through the use of multiple redundant sites, which makes it suitable for business continuity and disaster recovery. Nonetheless, most major cloud computing services have suffered outages and IT and business managers are able to do little when they are affected.
- **Scalability** via dynamic ("on-demand") provisioning of resources on a fine-grained, self-service basis near real-time, without users having to engineer for peak loads. Performance is monitored and consistent and loosely-

coupled architectures are constructed using web services as the system interface.

- **Security** typically improves due to centralization of data, increased security-focused resources, etc., but raises concerns about loss of control over certain sensitive data. Security is often as good as or better than traditional systems, in part because providers are able to devote resources to solving security issues that many customers cannot afford. Providers typically log accesses, but accessing the audit logs themselves can be difficult or impossible.
- **Sustainability** comes about through improved resource utilization, more efficient systems, and carbon neutrality. Nonetheless, computers and associated infrastructure are major consumers of energy.

ROLES OF CLOUD TOWARDS IN RECENT TIME

- **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.

- **User**

A user is a consumer of *cloud computing*. The privacy of users in cloud computing has become of increasing concern. The rights of users are also an issue, which is being addressed via a community effort to create a bill of rights.

- **Vendor**

A vendor sells products and services that facilitate the delivery, adoption and use of *cloud computing*. For example:

- Computer hardware (Dell, HP, IBM, Sun Microsystems)
    - Storage (Sun Microsystems, EMC, IBM)
    - Infrastructure (Cisco Systems)
- Computer software (3tera, Hadoop, IBM, RightScale)
    - Operating systems (Solaris, AIX, Linux including Red Hat)
    - Platform virtualization (Citrix, Microsoft, VMware, Sun xVM, IBM)

ARCHITECTURE OF CLOUD COMPUTING

This resembles UNIX philosophy of having multiple programs each doing one thing well and working together over universal interfaces. Complexity is controlled and the resulting systems are more manageable than their monolithic counterparts. The two most significant components of cloud computing architecture are known as the front end and the

back end. The front end is the part seen by the client, i.e. the computer user. This includes the client's network (or computer) and the applications used to access the cloud via a user interface such as a web browser. The back end of the cloud computing architecture is the 'cloud' itself, comprising various computers, servers and data storage devices.

KEY FEATURES

- Agility improves with users' ability to rapidly and inexpensively re-provision technological infrastructure resources.
- Cost is claimed to be greatly reduced and capital expenditure is converted to operational expenditure. This ostensibly lowers barriers to entry, as infrastructure is typically provided by a third-party and does not need to be purchased for one-time or infrequent intensive computing tasks. Pricing on a utility computing basis is fine-grained with usage-based options and fewer IT skills are required for implementation (in-house).
- Device and location independence enable users to access systems using a web browser regardless of their location or what device they are using (e.g., PC, mobile). As infrastructure is off-site (typically provided by a third-party) and accessed via the Internet, users can connect from anywhere.
- Multi-tenancy enables sharing of resources and costs across a large pool of users thus allowing for:
    - Centralization of infrastructure in locations with lower costs (such as real estate, electricity)
    - Peak-load capacity increases (users need not engineer for highest possible load-levels)
    - Utilization and efficiency improvements for systems that are often only 10–20% utilized.
- Reliability is improved if multiple redundant sites are used, which makes well designed cloud computing suitable for business continuity and disaster recovery. Nonetheless, many major cloud computing services have suffered outages, and IT and business managers can at times do little when they are affected.
- Scalability via dynamic ("on-demand") provisioning of resources on a fine-grained, self-service basis near real-time, without users having to engineer for peak loads. Performance is monitored and consistent and loosely coupled architectures are constructed using web services as the system interface. One of the most important new methods for overcoming performance bottlenecks for a large class of applications is data parallel programming on a distributed data grid.
- Security could improve due to centralization of data, increased security-focused resources, etc., but concerns can persist about loss of control over certain sensitive data, and the lack of security for stored kernels. Security is often as good as or better than under traditional systems, in part because providers are able to devote resources to solving security issues that many customers cannot afford. Providers typically log accesses, but accessing the audit logs themselves can be difficult or impossible. Furthermore, the complexity of security is greatly increased when data is distributed over a wider area and / or number of devices.
- Maintenance cloud computing applications are easier to maintain, since they don't have to be installed on each user's computer. They are easier to support and to improve since the changes reach the clients instantly.
- Metering cloud computing resources usage should be measurable and should be metered per client and application

on daily, weekly, monthly, and annual basis. This will enable clients on choosing the vendor cloud on cost and reliability (QoS).

ISSUES WITH CLOUD

- **Privacy**

The Cloud model has been criticized by privacy advocates for the greater ease in which the companies hosting the Cloud services control, and thus, can monitor at will, lawfully or unlawfully, the communication and data stored between the user and the host company. Instances such as the secret NSA program, working with AT&T, and Verizon, which recorded over 10 million phone calls between American citizens, causes uncertainty among privacy advocates, and the greater powers it gives to telecommunication companies to monitor user activity. While there have been efforts (such as US-EU Safe Harbor) to "harmonise" the legal environment, providers such as Amazon still cater to major markets (typically the United States and the European Union) by deploying local infrastructure and allowing customers to select "availability zones.

- **Legal**

In March 2007, Dell applied to trademark the term "cloud computing" (U.S. Trademark 77,139,082) in the United States. The "Notice of Allowance" the company received in July 2008 was cancelled in August, resulting in a formal rejection of the trademark application less than a week later. Since 2007, the number of trademark filings covering cloud computing brands, goods and services has increased at an almost exponential rate. As companies sought to better position themselves for cloud computing branding and marketing efforts, cloud computing trademark filings increased by 483% between 2008 and 2009. In 2009, 116 cloud computing trademarks were filed, and trademark analysts predict that over 500 such marks could be filed during 2010.

- **Security**

The relative security of cloud computing services is a contentious issue which may be delaying its adoption. Some argue that customer data is more secure when managed internally, while others argue that cloud providers have a strong incentive to maintain trust and as such employ a higher level of security. The Cloud Security Alliance is a non-profit organization formed to promote the use of best practices for providing security assurance within Cloud Computing.

- **Availability and Performance**

In addition to concerns about security, businesses are also worried about acceptable levels of availability and performance of applications hosted in the cloud.

There are also concerns about a cloud provider shutting down for financial or legal reasons, which has happened in a number of cases.

- **Sustainability and Siting**

Although cloud computing is often assumed to be a form of "green computing", there is as of yet no published study to substantiate this assumption. Siting the servers affects the environmental effects of cloud computing. In areas where climate favors cooling and lots of renewable electricity is available the environmental effects will be more moderate. Thus countries with favourable conditions, such as Finland, Sweden and Switzerland, are trying to attract cloud computing

data centres.

POPULAR CLOUD APPLICATIONS: A CASE STUDY

Applications using cloud computing are gaining popularity day by day for their high availability, reliability and utility service model. Today many cloud providers are in the IT market. Of those Google App-Engine, Windows Azure and Amazon EC2, S3 are prominent ones for their popularity and technical perspective.

Amazon EC2 and S3 Services

Amazon Elastic Computing (EC2) [is one of the biggest organizations to provide Infrastructure as a Service. They provide the computer architecture with XEN virtual machine. Amazon EC2 is one of the biggest deployments of XEN architecture to date. The clients can install their suitable operating system on the virtual machine. EC2 uses Simple Storage Service (S3) for storage of data. Users can hire suitable amount CPU power, storage, and memory without any upfront commitment. Users can control the entire software stack from kernel upwards. The architecture has two components one is the EC2 for computing purposes and S3 is for storage purposes.

- **Simple Storage Service:** S3 can be thought as a globally available distributed hash table with high-level access control. Data is stored in name value pairs. Names are like UNIX file names and the value can be object having size up-to 5 GB with up-to 4K of metadata for each object. All objects in Amazon's S3 must _t into the global namespace. This namespace consists of a “bucket name" and an “object name". Bucket names are like user names in traditional email account and provided by Amazon on first come first serve basis. An AWS (Amazon Web Services) account can have maximum of 100 buckets. Amazon has a very impressive scheme of authentication in comparison to other cloud services. Every AWS account has an Access Key ID and a Secret Key. The ID is of 20 characters and the Key is a 41 character string. When signing HMAC is first computed for the sign request parameters using that Key. And in the Amazon server that HMAC is again computed and compared with the value previously computed in the client side. These requests also include timestamp to prevent replay attacks.
- **Elastic Compute Cloud:** As the name implies EC2 rents cloud of computers to the users with flexibility of choosing the configuration of the virtual machine like RAM size, local disk size, processor speeds etc. Machines that deliver EC2 services are actually virtual machines running on top of XEN platform. Users can store a disk image inside S3 and create a virtual machine in EC2 using tools provided by Amazon. This virtual machine can be easily instantiated using a java program and can also be monitored. As EC2 is based on XEN it supports any linux distribution as well as other OSs. Amazon does not promise about reliability of the EC2 computers. Any machine can crash at any moment and they are not backed up. Although these machine generally don't crash according to the experience of the users but it is safe to use S3 to store information which is more reliable and replicated service. EC2 security model is similar to that of S3. The only difference is that the commands are signed with an X 509 private key. But this key is downloaded from AWS account so the security depends fundamentally on the AWS username and password.

Google App-Engine

Google App-Engine is a platform for developing and deploying web applications in Google's architecture. This provides Platform as a Service to the cloud users. In 2008 Google App-Engine was first released as beta version.

Languages supported by Google App-Engine are python, java and any extension of JVM languages. App-Engine requires developers to use only languages which are supported by it and this is also applied with APIs and frameworks. Now Google App-Engine allows storing and retrieving data from a Big Table non-relational database.

Windows Azure

Windows Azure is an intermediate in the spectrum flexibility vs. programmer convenience. These systems use .NET libraries to facilitate language independent managed environment. This service falls under the category of Platform as a Ser- vice. Though it is actually in between complete application framework like Google App-Engine and hardware virtual machines like EC2. Azure applications run on machines in Microsoft data centers. By using this service customers can use it to run applications and store data on internet accessible machines owned by Microsoft. Windows Azure platform provides three fundamental components - compute component, storage component and fabric component.

CLOUD COMPUTING APPLICATIONS IN INDIAN CON-TEXT

Today most of the studies in cloud computing is related to commercial benefits. But this idea can also be successfully applied to non-profit organizations and to the social benefit. In the developing countries like India Cloud computing can bring about a revolution in the field of low cost computing with greater efficiency, availability and reliability. Recently in these countries e-governance has started to flourish. Experts envisioned that utility based computing has a great future in e-governance. Cloud computing can also be applied to the development of rural life in India by building information hubs to help the concerned people with greater access to required information and enable them to share their experiences to build new knowledge bases.

E-Governance

E-Governance is an interface between Government and public or this can be an interface between two governments or between government and business organizations. Objectives are generally to improve efficiency and effectiveness to serve public demand and to save costs for online services. This requires Government to have the will to decentralize the responsibilities and processes and start to have faith on electronic and internet systems. E-government is a form of e-business in governance and refers to the processes and structures needed to deliver electronic services to the public (citizens and businesses), collaborate with business partners and to conduct electronic transactions within an organizational entity. This E-Governance can be greatly improved by utility computing. Impacts of Technology in E-governance are as follows:

- **24/7 Service Model:** Systems and services require high availability. Get the citizens feel that Government is always at their service.
- **Need for Content:** Web contents should be regularly updated and the information provided to the public should be sufficient. Respective departments should be responsible for providing the information.
- **Human Resource:** Building these IT skilled resources would need properly trained personals. This would make government to compete with other private organizations.
- **Security:** Sensitive Government data is to be highly secured. Policies are to be taken seriously maintained and designed.

- **Privacy:** Personal data should be given sufficient privacy. It can be a difficult issue if data is stored across different departments and computer systems.

Rural Development

In the context of rural development cloud computing can also be used to success for its centralized storage and computing facility and utility based pay model. As per [3] 72.2% of total Indian population resides in rural areas. According to the survey conducted by " Hole in the Wall project" computer literacy among boys and girls of age group 8-14 in rural area varies across the regions of India. It is 40- 50% in most of the regions. So the computer literacy is not a concern in rural India and also in it shown that learning rate is pretty high for computer literacy. Agriculture is India's biggest employment source, accounting for 52% employment in India . And agricultural sector contributes to 20% of country's total GDP. So it is very important to make a serious attempt to develop rural India. Rural development can be in the form of education, agriculture, health, culture or in any other fields. Now a day's most of the villages have some access to electricity and cellular phone. So there is technical feasibility of establishing computer systems. But the mentality of the people haven't been changed that much and that's why the spread of personal computer is not that much significant in the villages. We think this growth rate can be enhanced if the computing system is really cheap, easy to operate with minimum level of knowledge, without upfront commitment and more essentially if the system is helpful to enhance their life style. The main aim of the system is to make the people in rural areas to have access to recent technology and with the help of the computing system enhance their standard of living and also this would lead to a greater good of developing the nation.

COMPARISONS

Cloud computing derives characteristics from, but should not be confused with:

- Autonomic Computing — "computer systems capable of self-management".
- Client–Server Model – Client–server computing refers broadly to any distributed application that distinguishes between service providers (servers) and service requesters (clients).
- Grid Computing — "a form of distributed computing and parallel computing, whereby a 'super and virtual computer' is composed of a cluster of networked, loosely coupled computers acting in concert to perform very large tasks."
- Mainframe Computer — powerful computers used mainly by large organizations for critical applications, typically bulk data processing such as census, industry and consumer statistics, enterprise resource planning, and financial transaction processing.
- Utility Computing — the "packaging of computing resources, such as computation and storage, as a metered service similar to a traditional public utility, such as electricity".
- Peer-to-Peer – a distributed architecture without the need for central coordination, with participants being at the same time both suppliers and consumers of resources (in contrast to the traditional client–server model).

CONCLUSIONS

Cloud computing is a newly developing paradigm of distributed computing. Virtualization in combination with utility computing model can make a difference in the IT industry and as well as in social perspective. Though cloud

computing is still in its infancy but it's clearly gaining momentum. Organizations like Google, Yahoo, and Amazon are already providing cloud services. The products like Google App-Engine, Amazon EC2, and Windows Azure are capturing the market with their ease of use, availability aspects and utility computing model. Users don't have to be worried about the hinges of distributed programming as they are taken care of by the cloud providers. They can devote more on their own domain work rather than these administrative works. Business organizations are also showing increasing interest to indulge themselves into using cloud services. There are many open research issues in this domain like security aspect in the cloud, virtual machine migration, dealing with large data for analysis purposes etc. In developing counties like India cloud computing can be applied in the e-governance and rural development with great success. Although as we have seen there are some crucial issues to be solved to successfully deploy cloud computing for these social purposes. But they can be addressed by detailed study in the subject.

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