Perspectives of Cloud Computing: An Overview

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Perspectives of Cloud Computing: An overview

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Abstract
Cloud computing has sparked a huge amount of interest in the computer industry. According to the market research and analysis firm "International Data Corporation" (IDC – www.idc.com), suggests that the market for cloud computing services was $16bn in 2008 and will rise to $42bn per year by 2012 [1]. In Simple words, cloud computing means remote computing. Cloud computing is part of general architecture trend in the computer industry, moving from users doing computing on their own hardware using copies of software that they own, to users doing computing on provider's machines (virtual machines) somewhere in the cloud, using software that they subscribe [2]. More use of cloud computing raising the security issues also. This paper will first introduce the cloud computing followed by types and categories of cloud computing and security perspective of cloud computing and final section summarize and conclude with future promises of cloud computing trends.
Keywords: Cloud computing, Remote Computing, Security.

1. Introduction

The term computing is changing its faces from the desktop computing to the Internet computing and this face has used several other looks for example utility computing, cluster computing, Grid computing and currently the most hot buzzword cloud computing [3]. The term "Cloud Computing" is today's term and tomorrows promise. In simple words cloud means the Internet and cloud computing means remote computing [4, 5]. The Internet normally visualized as available in clouds because no one exactly knows and no one really worry to know from where the information is being retrieved and updated. Keeping in view this fact the cloud computing refer to the virtualization of an existing data centre or server in order to provide users with applications and utility remotely. This involved access to the cloud as service, where applications are available on demand on a subscription basis, commonly known as pay-per-use [6].

Cloud computing is an environment to describe both the platform and type of application. According to [4, 7] cloud computing evolved into following ways:

> First Generation Cloud Computing (known as Web 1.0): in this type of cloud computing users use the Internet to retrieved information from several servers in the form of static pages. For example personal websites, newspapers, newsgroups, web-based email addresses etc. Technically speaking it is not known as cloud computing.

> Second Generation Cloud Computing (known as Web 2.0): in this type of cloud computing user use the Internet to retrieve information from several servers in the form of static, dynamic and active pages. For example buying and selling on e-Commerce and e-Business sites with more interactivity and collaboration, blogs were aggregated together into large collection on clouds,

social networking, instant connectivity, and new level of interactivity over the Web etc. Technically speaking it is also not known as cloud computing.

Third Generation Cloud Computing (known as Web 3.0): in this type of cloud computing users use the Internet to retrieve and update information from several servers and Data Centers. Contents are becoming executable Web. Users in this type use the services on pay-as-you go basis and the services will be provided on demand basis. For example Amazon's Elastic Computing Cloud (EC2), Salerforce.com, Google, Microsoft [8, 9] and IBM's Technology Adoption Program (TAP) [10] are already up on the cloud. A typical third generation cloud computing is shown in Figure-1.
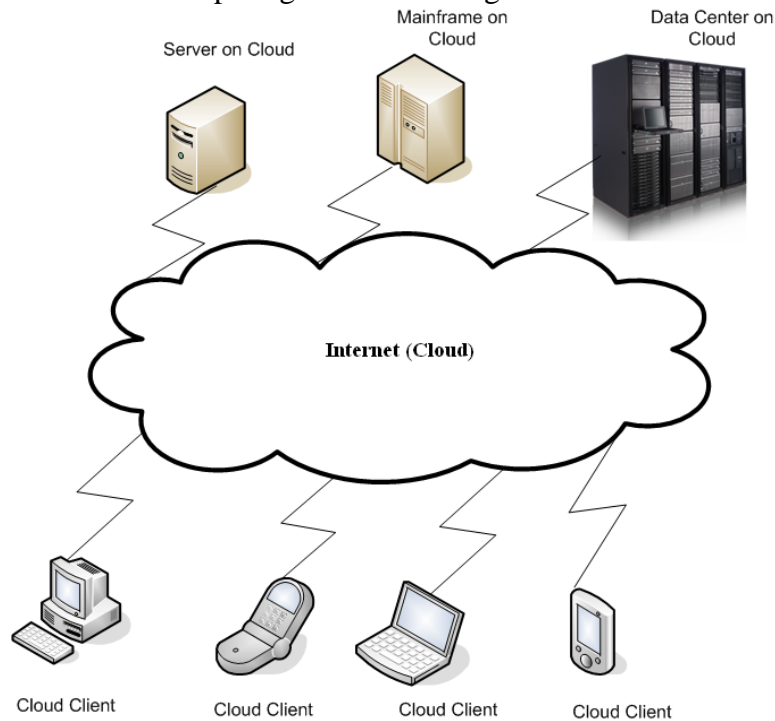

Figure-1: Cloud Computing

In cloud computing environment servers and data centers can be physically machines or virtual machines and the applications on cloud can be accessible through the Internet. [10]. This paper is written keeping in view the security perspective of cloud computing as today the Internet is changing dramatically. More and more users are joining the Internet and on the other hand more and more giant venders are joining the cloud computing for example Amazon, Salerforce.com, Google, Microsoft and IBM [8, 9 and 10]. The more the users use the cloud computing the more the security concern. From the user point of view, the security of their data and application, which are maintained and controlled over the cloud are the big issues. This paper first highlight the types and categories of cloud computing. Latter section explores the security perspective of cloud computing. Final section of the paper summarizes and concludes the future promises of cloud computing.

2. Categories of Cloud Computing

Today the cloud computing changes the way we work. To justify this, we need to understand how we are working? Working means doing some job. The only restriction on us is to have the Internet access. If we are equipped with the Internet access then it is possible to work from home, it is possible to be working on the road,

or in office (traditional work). Today we are not concerned regarding physical boundaries of our work environment.

Cloud computing is not the technology but it is an environment, which is divided into three basic categories [5, 7, 8, 11, 12 and 13] and these categories are basically three services, which are being offered and available to end users, institutions, business organizations etc. These are Infrastructure as a Service (IaaS – e.g. hardware, utility etc.), Platform as a Service (PaaS – e.g. operating systems) and Software as a Service (SaaS – e.g. applications etc.). Before understanding these categories, we need to understand that all these categories can be found in several types.

2.1. Types of Cloud:
The cloud computing environment can be found in various flavors based on their deployment and usage [5, 8]:

2.1.1. Public cloud:
This facility is provided for all, that's why it is called public cloud. Any individual or corporation or any organization can use the cloud for computing. Public clouds are administrated mostly by 3rd party or venders over the Internet and services are offered on pay-per-use basis also known as provider clouds. For example, New York Times archive project using Amazon EC2 instances and storage to generate PDFs of 11 million articles for the paper's archives, at small fraction of traditional costs. Public clouds allow organizations to deliver highly scalable and reliable applications rapidly with affordable cost and are widely used in the development, deployment and management of enterprise applications. Security is major concern in public cloud.

2.1.2. Private cloud:
This facility is not provided for all, that's why it is called private cloud. In this type cloud computing resides within the boundaries of an organization and is used exclusively for the organizations benefits and also known as internal cloud. They are usually built by IT divisions within enterprises for the optimization and utilization of infrastructure within that enterprise by provisioning the infrastructure with applications using the concept related to gird and virtualizations. Private cloud uses high level of automation, with reduced operation costs and administrative overheads. They help to improve average server utilization, allowing usage of low-cost servers and hardware while providing higher efficiencies. IT division in the organization may have to invest in buying, building and managing the cloud independently.

2.1.3. External cloud:
This facility is not provided to all, but to limited clients or to restricted suppliers for example. This type of cloud computing environment is used outside of the boundaries of the organization, though it is not necessarily a public cloud. Some external clouds make their cloud infrastructure available to certain other organizations, but not to the general public. For example, setup for the purpose of B2B e-Commerce, where organization allows restricted suppliers to access their data.

2.1.4. Hybrid cloud:
This type of cloud computing is actually any combination of public and/or private and/or external clouds environment.

2.2. Categories of Cloud:

The term cloud computing is simply defined as "remote computing or computing on the Internet", as compared to the traditional computing on desktop. A real and pure definition of cloud computing is in need to differentiate between today's cloud computing vs. software on the Web, because Web software has been around for more than a decade and cloud computing is just a new arrival. Cloud computing changes all that, by incorporating and introducing, virtualization technology, that allows the physical infrastructure to be rented for less amount compared to the old way to engineer Web software. According to the National Institute of standards and Technology (NIST), 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 service provider interaction [7]. According to NIST cloud computing is categorizes into three "as a service" offerings, namely infrastructure, platform and software.

2.2.1. Infrastructure as a Service or IaaS:

In old days if we need a server for our organization, we need to spend much higher amount. Nowadays with the presence of cloud infrastructure, we can buy or rent actually a virtual server over the Internet as easy and simple as just signing up for the web-based email account. That's why it is also known as Hardware as a Service (HaaS). What we mean by virtual server here, is not real. We can not actually walk into a room and touch this server. Instead we are managing it through "virtualization" software, such as VMware. Also very important to note that here we are not talking about only one server, in reality cloud infrastructure is not limited to a single server, but rather relies on a shared pool of servers. Virtualization means something behind the scenes enabling technology that makes cloud infrastructure possible. User of IaaS use the APIs (Application Program Interfaces) to start, stop, access and configure their virtual servers and storage etc. Amazon is one of the major players in providing IaaS solutions. Amazon Elastic Compute Cloud (EC2) provides a large computing infrastructure and a service based on hardware virtualization. With the help of Amazon Web Services, user can create Amazon Machine Images (AMIs) and save them as templates from which multiple instances can be run. Also Amazon provides storage services with the Amazon Simple Storage Service (S3), organizations can use Amazon's S3 to host large amount of data accessible form anywhere in the world [5, 7, 8, 11, 12 and 13].

2.2.2. Platform as a Service or PaaS:

In simple words platform means software architecture upon which one can build computing solutions (operating systems, for example). In old days new platforms were introduced and organizations were arranging comprehensive training for their skilled worker to truly understand the platform and then transforming their environments to new platforms. Nowadays with the help of PaaS, platforms can enter into new market within days, instead of years, because lower skill requirements are needed to create new software applications. Now with PaaS users may not need to ever install, upgrade or host, but everything is up upon the cloud. Here, cloud platforms also include online tools and APIs that make it easier for organizations to build on top of the platform (sometimes known as Middleware). Organization can benefit from PaaS in the form of lower costs, lower risks, faster time-to market, higher

profit margins, rapid prototyping, security and interoperability. Force.com (an outgrowth of www.salesforce.com), GoogleApps (http://docs.google.com) and Microsoft's Azure (www.microsoft.com/windowsazure) are good example of PaaS [5, 7, 8, 11, 12 and 13].

2.2.3. Software as a Service or SaaS:

In the old days SaaS was known as Aplication Service Provider (ASP). The ASP approach provides subscription to software that is hosted or delivered over the Internet. The most important and most visible of three components is cloud software, without which there is no need for platform or infrastructure. Cloud computing and cloud software, i.e. SaaS, are not the same. Here in this model there is no need to install and run the application on the customer's local computer. SaaS, therefore, alleviates the customer's burden of software maintenance, and reduces the expense of software purchases by on-demand basis. Cloud software is just a software part of the cloud computing. For example in SaaS, the vendor supplies the hardware infrastructure; the software product interacts with the user through a front-end portal. Services can be anything from Web-based email to inventory control and database processing. Because the service provider hosts both the application and the data, the end user is free to use the service from anywhere. SaaS are at the top end of the cloud computing stack and they provide end users with an integrated service comprising hardware, development platforms and applications. Users are not allowed to customize the service but instead getting access to a specific application hosted in cloud. Examples of SaaS are Google Documents (http://docs.google.com) and Google Calendar (www.google.com/calendar), which are delivered for free to the Internet users and charged for professional quality services. Other examples are Salesforce.com and Clarizen.com, which respectively provide online CRM and project management services [5, 7, 8, 11, 12 and 13].

Some researchers are referring new categories of cloud, for example Supercomputing as a Service (SCaaS), where supercomputer-like capabilities to handle large data sets are offered, example is again Amazon. Also High Performance Computing as a Service (HPCaaS), where spcial HPC cloud software including open source software like Univa UD, makes it possible to turn computing nodes on and off as needed. With cloud HPC, the concept is that a supercomputer never rests idle, doesn't become comparatively outdated in few years, and has no hard limits on scale. The future of cloud HPC is yet to be determined [12]. Other researchers in [14] describe IPMaaS (Identity and Policy Management as a Service), in which provider manages identity and/or access control policy for customer and NaaS (Network as a Service), in which provider offers virtualization networks (e.g. VPNs).

3. Security Perspective of Cloud Computing

The first question that comes to our mind, is whether it is safe to put our organizational data on the cloud, because cloud means data is being stored somewhere and we probably don't even know where or how. Security is the big concern along with cloud environment. Each and every organization needs to know that their data and applications are secure, and the question of cloud computing security must be addressed. The security issue sparks; when in a distributed denial-of-service (DDOS) attack against Bitbucket.org (www.bitbucket.org/), a popular Website hosted on Amazon Web Services (AWS), was recorded. Bitbucket.org founder Jesper Noehr

said "they have quality of service (QoS) on their internal network, but it didn't work", he also added that "I was a bit surprised this was something we had to point out to them (AWS – administration)" [15].

According to [16] following figure depicts the reasons "why do people like cloud computing" as shown in figure-2. Similar research is conducted, which shows "What is scary about cloud computing", as shown in Figure-3.
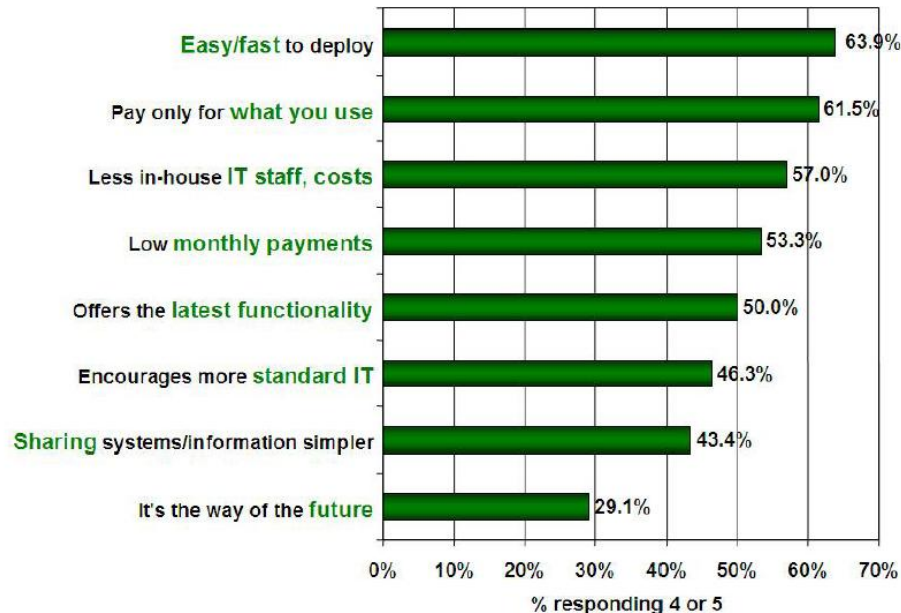

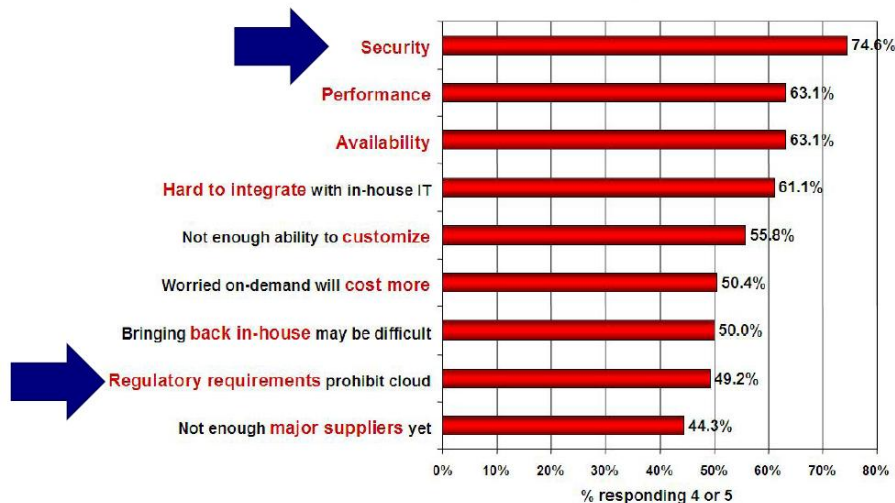**Figure-2: Why do people like cloud computing**

Figure-3: What is scary about cloud computing

However, according to NIST there are several security advantages of cloud computing [4, 12]:

- Centralized data storage
- Shifting public data to external cloud reduced the exposure of the internal sensitive data
- Cloud homogeneity makes security auditing / testing simple
- Cloud enables automated security management
- Redundancy / Disaster recovery is easier

- Monitoring of data access is easier
- Increased uncertainty (for hackers to find out which physical component to steal)
- Virtualization allows a rapid replacement of a compromised server located into the cloud without major cost or damage
- Extended logs can be activated because the cloud is big enough to store large collection of data
- Security changes can be easily tested and implemented.

In [1] security, legal and privacy issues are very well written in details, including European Network and Information Security Agency (ENISAs) report on security issues and other researchers concerned were also raised.

According to AWS (http://aws.amazon.com/security/), they had improved their security in following perspectives.
- Certification and Accreditations (AWS has completed a SAS70 Type II Audit certificate)
- Physical Security (AWS has improved their physical security, after several years of experience as they are pioneer in cloud computing)
- Secure Service (AWS has also improved their, specially restricting unauthorized access or usage etc.)
- Data Privacy (AWS has also adapted encryption and backup & edundancy procedures are improved)

4. Summery & Conclusion

In the past business applications (e.g. SAP, Microsoft, and Oracle) have always been too complicated and expensive. Lots of efforts needed to install, configure and run these applications. Physical space (e.g. office space cooling system etc.), hardware (e.g. server, storage etc.), training and resources to develop and test etc. are very much required. Cloud computing is today's way to do business. Today you do not need to do lots of efforts to install, configure and run these applications. No need of physical space, hardware and training etc. Just log in to the cloud system, customize it according to your need and run it. Also you do not need to buy any expensive server or application; you just subscribe it on cloud. Simply cloud means, lots of general purpose hosts available to us, central management is going-on on our application, distributed data storage is available, ability to move applications from one system to another and many other benefits. Cloud computing is a new and promising paradigm delivering IT services as computing utilities.

Security is a major concern in cloud computing. Most of the important security concern is "control on data". The solution lies in encryption. App and Network security concern is also important, but under the control of provider, as in previous section AWS has already improved security and other venders are also working on the same direction, for example, skylab community project of cloudsecurity.org (http://cloudsecurity.org/), National Institute of Standards and Technology (NIST) (http://csrc.nist.gov/groups/SNS/cloud-computing/index.html), Sun Cloud Computing (http://www.sun.com/solutions/cloudcomputing/security.jsp) and Cloud Security Alliance (CSA) (http://www.cloudsecurityalliance.org/) are few examples. Accessing organizations' most secrete and important data on the cloud is also the main concern, which can be overcome through trust between providers and customers. Also there

are few other security concerns, for example, Front-end attacks against same-origin, attacks against the application virtual machine and vulnerabilities in the Web application server [16].

Future of cloud is promising. More and more venders will move to cloud. There are of course technological challenges, but also there are issues with balancing usage cost and services delivered. Future of cloud will be in the form of Trusted Cloud Computing Platform (TCCP) that will enabled IaaS services to provide a closed box execution environment [17]. According to [18] the future of cloud computing as a viable technology and hence a viable business too. One major shift in the near future will be towards private data centers. Also among the providers of cloud computing services we will see a trend towards providing one company's cloud solution on another company's platform. AMD recently announced that they are building a specialty supercomputer to deliver gaming through a computing cloud. These, previously mentioned news will encourage the cloud computing business model. The promise of cloud computing is one that can revolutionize computing and change the way we go about our business. Services would become more ubiquitous – available on our mobile phones or from our computer. It is also a path towards better data center utilization – this is essential as the need for computation increases in the face of growing environmental challenges.

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