Cloud computing - concepts, architecture and challenges

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2 authors:

Yashpalsinh Jadeja

Kirit Modi

Ganpat University, U V Patel College of Engineering, Kherva, India

Cloud Computing – Concepts, Architecture and Challenges

Yashpalsinh Jadeja
Dept. of Computer Engineering & IT
U. V. Patel College of Engineering, Ganpat University
Kherva (Mahesana), Gujarat, India
yashpaljadeja@gmail.com

Kirit Modi
Dept. of Computer Engineering & IT
U. V. Patel College of Engineering, Ganpat University
Kherva (Mahesana), Gujarat, India
kirit.modi@ganpatuniversity.ac.in

***Abstract*— With the advent internet in the 1990s to the present day facilities of ubiquitous computing, the internet has changed the computing world in a drastic way. It has traveled from the concept of parallel computing to distributed computing to grid computing and recently to cloud computing. Although the idea of cloud computing has been around for quite some time, it is an emerging field of computer science. Cloud computing can be defined as a computing environment where computing needs by one party can be outsourced to another party and when need be arise to use the computing power or resources like database or emails, they can access them via internet. Cloud computing is a recent trend in IT that moves computing and data away from desktop and portable PCs into large data centers. The main advantage of cloud computing is that customers do not have to pay for infrastructure, its installation, required man power to handle such infrastructure and maintenance. In this paper we will discuss what makes all this possible, what is the architectural design of cloud computing and its applications.**

Keywords—applications, architecture, business component of cloud computing, cloud computing, issues

I. INTRODUCTION

The term "cloud" originates from the world of telecommunications when providers began using virtual private network (VPN) services for data communications [1]. Cloud computing deals with computation, software, data access and storage services that may not require end-user knowledge of the physical location and the configuration of the system that is delivering the services. Cloud computing is a recent trend in IT that moves computing and data away from desktop and portable PCs into large data centers [2]. The definition of cloud computing provided by National Institute of Standards and Technology (NIST) says that: "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. [3]" With the large scale proliferation of the internet around the world, applications can now be delivered as services over the internet. As a result this reduces the overall cost.

The main goal of cloud computing is to make a better use of distributed resources, combine them to achieve higher throughput and be able to solve large scale computation problems. Cloud computing deals with virtualization, scalability, interoperability, quality of service and the delivery models of the cloud, namely private, public and hybrid.

II. HISTORY

The underlying concept of cloud computing was introduced way back in 1960s by John McCarthy. His opinion was that "computation may someday be organized as a public utility. [4]" Also the characteristics of cloud computing were explored for the first time in 1966 by Douglas Parkhill in his book, *The Challenge of the Computer Utility*[4]. The history of the term *cloud* is from the telecommunications world, where telecom companies started offering Virtual Private Network (VPN) services with comparable quality of service at a much lower cost. Initially before VPN, they provided dedicated point-to-point data circuits which was a wastage of bandwidth. But by using VPN services, they can switch traffic to balance utilization of the overall network. Cloud computing now extends this to cover servers and network infrastructure.

Many players in the industry have jumped into cloud computing and implemented it. Amazon has played a key role and launched the Amazon Web Service (AWS) in 2006. Also Google and IBM have started research projects in cloud computing. Eucalyptus became the first open source platform for deploying private clouds.

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III. CHARACTERISTICS OF CLOUD COMPUTING

- In cloud computing, users access the data, applications or any other services with the help of a browser regardless of the device used and the user's location. The infrastructure which is generally provided by a third-party is accessed with the help of internet. Cost is reduced to a significant level as the infrastructure is provided by a third-party and need not be acquired for occasional intensive computing tasks.
- Less IT skills are required for implementation.
- Reliable service can be obtained by the use of multiple sites which is suitable for business continuity [4] and disaster recovery [4]. However, sometimes many cloud computing services have suffered outages and in such times its users can hardly do anything [5].

- Sharing of resources and costs amongst a large collection of users allows efficient utilization of the infrastructure.
- Maintenance is easier in case of cloud computing applications as they need not be installed on each user's computer.
- Pay per use facility allows measuring the usage of application per client on regular bases.
- Performance can be monitored and thus it is scalable.
- Security can be as good as or better than traditional systems because providers are able to devote resources to solving security issues that many customers cannot afford. However, security still remains an important concern when the data is quite confidential. This delays adoption of cloud computing to some extent [6, 7].

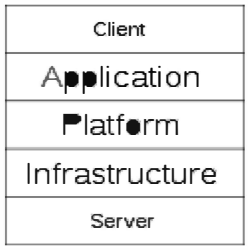
IV. CLOUD COMPUTING ARCHITECTURE

Cloud computing system can be divided into two sections: the *front end* and the *back end* [8]. They both are connected with each other through a network, usually the internet. Front end is what the client (user) sees whereas the back end is the cloud of the system. Front end has the client's computer and the application required to access the cloud and the back has the cloud computing services like various computers, servers and data storage.

Monitoring of traffic, administering the system and client demands are administered by a central server. It follows certain rules i.e., protocols and uses a special software called the *middleware* [8]. Middleware allows networked computers to communicate with each other.

A. Layers and Services of Cloud Computing Architecture

The below diagram shows the different layers of cloud computing architecture [4].



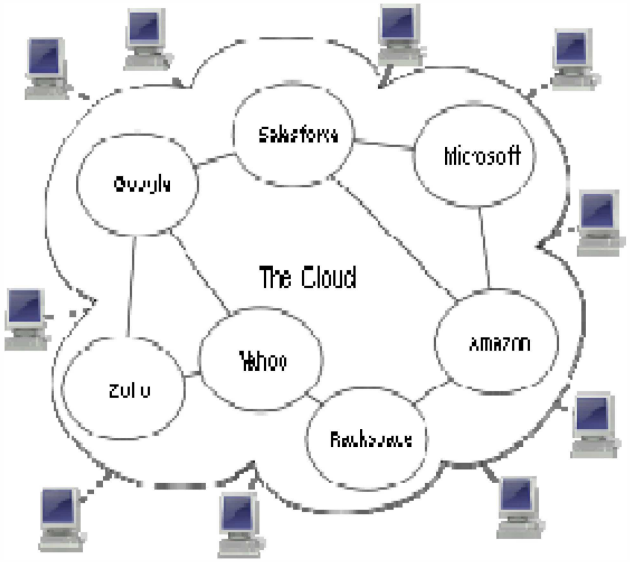
A *cloud client* consists of computer hardware and/or computer software which relies on cloud computing for application delivery, or that is specifically designed for delivery of cloud services [9].

A *cloud application* delivers "*Software as a Service (SaaS)*" over the internet, thus eliminating the need to install and run the application on the users system [9]. Important characteristics of this are: [9] Network-based access and management of commercially available software that are managed from centralized locations and enabling customers to access these applications remotely through the internet. Examples of the key providers are SalesForce.com (SFDC), NetSuite, Oracle, IBM and Microsoft [10]. Google Apps is the most widely used SaaS.

Platform services "*Platform as a Service (PaaS)*" provide a computing platform using the cloud infrastructure. It has all the application typically required by the client deployed on it. Thus the client need not go through the hassles of buying and installing the software and hardware required for it. Through this service developers can get a hold of all the systems and environments required for the life cycle of software, be it developing, testing, deploying and hosting of web applications. Key examples are GAE, Microsoft's Azure [10].

Infrastructure services "*Infrastructure as a Service (IaaS)*" provides the required infrastructure as a service. The client need not purchase the required servers, data center or the network resources. Also the key advantage here is that customers need to pay only for the time duration they use the service. As a result customers can achieve a much faster service delivery with less cost. Examples are GoGrid, Flexiscale, Layered Technologies, Joyent and Mosso/Rackspace [10].

Figure shows the conceptual diagram of Cloud Computing [4]:



Server consists of the characteristic computer hardware and/or software required for the delivery of the above mentioned services.

Figure shows the various cloud computing services with their examples:

SaaS	PaaS	IaaS
Software as a Service	Platform as a Service	Infrastructure as a Service
• Gov-Apps • Communication(email) • Collaboration • Productivity tools (office) • ERP	• Application Development • Security Services • Database Management	• Servers • Network • Storage • Management • Reporting
EXAMPLES : SalesForce.com NetSuite Oracle IBM Google Apps	EXAMPLES : GAE Microsoft's Azure Amazon EC2	EXAMPLES : GoGrid Flexiscale Joyent

All the above mentioned services are pay per use, which makes cloud computing an attractive option for those organizations which cannot afford buying, installing and maintaining the required services.

B. *Deployment of Cloud Computing Service*

For deploying a cloud computing solution, the major task is to decide on the type of cloud to be implemented. Presently three types of cloud deployment takes place – *public cloud, private cloud* and *hybrid cloud.* Figure below shows the overview of the deployment of these three clouds [11] :

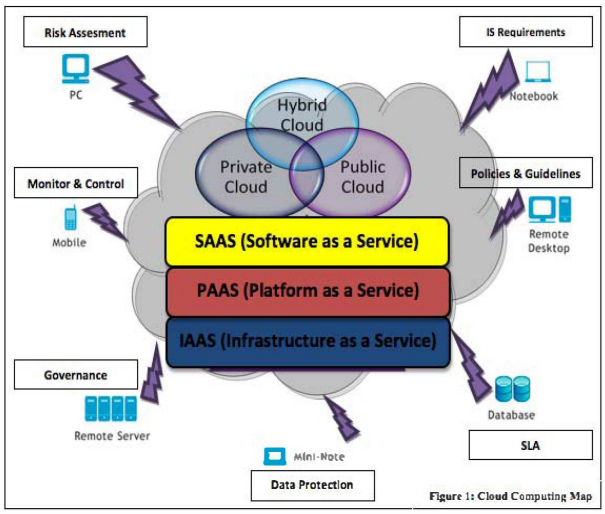


Figure 1: Cloud Computing Map

a. *Public Cloud*

Public cloud allows users' access to the cloud via interfaces using web browsers. Users need to pay only for the time duration they use the service, i.e., pay-per-use. This can be compared to the electricity system which we receive at our homes. We pay only for the amount of that we use. The same concept applies here. This helps in reducing the operation costs on IT expenditure. However public clouds are less secure compared to other cloud models as all the applications and data on the public cloud are more prone to malicious attacks. The solution to this can be that security checks be implemented through validation on both sides, by the cloud vendor as well as the client. Also both the parties need to identify their responsibilities within their boundaries of operation.

b. *Private Cloud*

A private clouds operation is within an organization's internal enterprise data center. The main advantage here is that it is easier to manage security, maintenance and upgrades and also provides more control over the deployment and use. Private cloud can be compared to intranet. Compared to public cloud where all the resources and applications were managed by the service provider, in private cloud these services are pooled together and made available for the users at the organizational level. The resources and applications are managed by the organization itself. Security is enhanced here as only the organizations' users' have access to the private cloud.

c. *Hybrid Cloud*

It is a combination of public cloud and private cloud. In this model a private cloud is linked to one or more external cloud services. It is more secure way to control data and applications and allows the party to access information over the internet. It enables the organization to serve its needs in the private cloud and if some occasional need occurs it asks the public cloud for intensive computing resources.

d. *Community Cloud*

When many organization jointly construct and share a cloud infrastructure, their requirements and policies then such a cloud model is called as a community cloud. The cloud infrastructure could be hosted by a third-party provider or within one of the organizations in the community.

V. ADVANTAGES OF CLOUD COMPUTING

a. *Easy Management*

The maintenance of the infrastructure, be it hardware or software is simplified, thus, less headaches for the IT team. Also applications that are quite storage extensive are more easier to use in the cloud environment compared to the same when used by the organization by its own. Also at the user level, what you mostly need is a simple web browser with internet connectivity.

b. *Cost Reduction*

The main advantage for SMEs lies here. Cloud computing drastically reduces the IT spending for SMEs. Costly systems need not be required for occasional use of intensive computing resources. Also the man power required for such systems is not required. Even simple applications like email can be set up and mostly free through applications like Google Apps. Also as most of the time such providers are quite reliable in terms of availability, it is clear winner.

c. *Uninterrupted Services*

Lower outages are provided by cloud computing services, thus providing uninterrupted services to the user. However, some occurrences of outages have occurred in

the past, like the Gmail outage in 2009. Also other cloud vendors like EC2 have failed at some point of time, but however, they are much more dependable compared to the infrastructure installed on the organization.

d. *Disaster Management*

In case of disasters, an offsite backup is always helpful. Keeping crucial data backed up using cloud storage services is the need of the hour for most of the organizations. Also cloud storage services not only keep your data off site, but they also ensure that they have systems in place for disaster recovery.

e. *Green Computing*

Harmful emissions due to extensive use of systems in organizations, electronic waste generated as the time passes and energy consumption is the main disadvantage of the present day computing systems. This can be reduced to some extent by using cloud computing services. This leads to environment preserving. Also the e-waste is generated to minimum extent.

VI. ISSUES OF CLOUD COMPUTING

Until now in this paper we defined about all the various architectures, deployment models and advantages of using cloud computing services. However as all new technology arrives, it brings with it some issues which may prove to be disastrous if not taken care of.

The biggest concerns about cloud computing are *security* and *privacy.* Handing over of crucial confidential data to another company gives jitters to some people. Corporate users will definitely hesitate to some extent in adopting cloud services as they can't keep their company's information under lock and key.

However companies offering cloud computing services counter argue to this say that they live and die by their reputations. Customers pay these companies as they are reliable in security measures. Otherwise, they would lose their clients. It's their concentration to provide best services to their clients.

Privacy is another factor. As these data are accessed from any location, it's possible the client's privacy could be compromised. One way to solve this issue is the use of proper authentication techniques. Another solution is to provide with an authorization - so that each user can access only the data and applications relevant to his or her job.

Replication time and costs also play an important role. How fast can the data be replicated is important for data resiliency.

Reliability is an issue. Servers in the cloud can have the same problems as the organization's resident servers. Downtimes can occur with cloud servers too.

VII. CONCLUSION

In this paper we have discussed a new wave in the field of information technology: cloud computing. We have also described its architecture, advantages and some issues. There is no doubt that cloud computing is the development trend for the future. We can have approximately infinite computing capabilities, scalability, pay-per-use scheme and so on. However this wave still needs to resolve some of its existing issues with urgency.

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