Cloud Computing: Architecture & Challenges

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Abstract: "Cloud computing", a relatively recent buzzword in IT industry that came into existence after decades of research in virtualization, utility computing, distributed computing, networking, and software services. A cloud introduces an IT environment which is invented for the motive of remotely provisioning measured and scalable resources. It has evolved as a new paradigm for exchanging information and services over the internet. It provides services to the users with greater reliability, flexibility, and scalability. It is used as service-oriented architecture which reduces information related overhead for End-Users. In this paper, we will discuss cloud computing concepts, architecture and we mainly focus on some of the challenges related to the cloud storage.

1. INTRODUCTION

Cloud Computing referred as Utility Computing that changes the state of storing Data (information and run application). Data are stored in the "Cloud" rather than in individual computers. Cloud is referred as software and hardware datacenter that supports users need. It proceeded from IBM's announcement of the "Blue Cloud" effort. In this paper, we take the description of cloud computing provided by The National Institute of Standards and Technology (NIST) [1,2] that covers all the essential aspects of cloud computing:

NIST definition of cloud computing: 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.

With the fast development of the internet, the resources have become more powerful, cheaper and more available. This development produced a new computing model called CLOUD COMPUTING. In this resources are provided by the On-Demand approach. It is the on-demand information technology service. It is based on dynamically virtualized resources. Example:-Network Server, Storage Application. Cloud Computing is classified into three different parts as follows [3]:

- Public Computing-The resources are available over the internet to all the users.

- Private Computing-The resources are provided to an organization via the intranet.

- Hybrid Computing-It is the combination of public and private computing that is depending on the requirement to provide resources.

These infrastructures enable companies to reduce overhead (cost, time) by eliminating the requirement for physical hardware by permit the companies to extract data On-Demand. It has been adopted by most popular internet application services with millions of users. Example websites like Google, Yahoo and Facebook [4]. Also by an industrial organization such as IBM, Microsoft and many other. Cloud Computing has made a strong impact on the information technology (IT) industry [5]. These IT industries have the aim to provide more reliable, powerful and cost-effective cloud platform. Cloud Computing provides various types of services such as Infrastructure as a Service(IaaS), Platform as a Service(PaaS) and Software as a Service(SaaS)[6]. This paper describes the overview of cloud computing, the architecture of cloud computing and then explain the main challenges of cloud computing. At the end, the paper concludes with the conclusion.

2. CLOUD COMPUTING

This section describes an overview of cloud computing including its definition and also comparison with related concepts. The main reason for the existence of cloud computing is to reduce IT overhead for the End users and also reduce the total of On-Demand services and many other things. Cloud computing uses technologies such as virtualization and utility-based pricing to meet the technological and economic requirements of user's demand for IT [4].

Cloud computing can be compared with following technologies:

A. Grid Computing

It is known as distributed computing that manages the network resources for collaboration [1]. Cloud computing and grid computing are similar in the manner of using distributed resources to achieve application level objective. In this, virtualization technologies run at multiple levels of software and hardware platforms for dynamic resource sharing.

B. Utility Computing

It's aimed at providing resources On-Demand and charging depends on usage. Cloud computing along with utility computing maximize resource utilization and reduce their operating cost.

C. Virtualization Computing

It forms the basic building blocks of cloud computing. So cloud computing is based dynamically on virtualization resources.
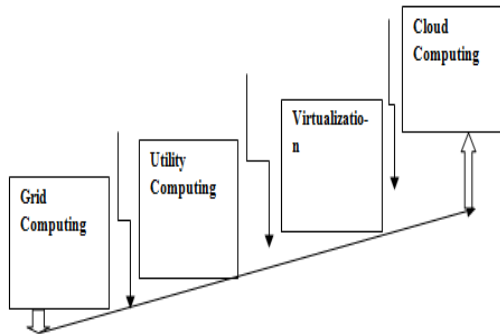

Fig.1: Grid to Cloud Evolution

Cloud computing contains virtual cloud in which user information and application are stored. The user does not have to depend on computer infrastructure. A complete package of grid computing and utility computing is termed under a buzzword known as cloud computing.

Brief introduction of major cloud computing services that we have described under introduction section is as follows [6]:

- *Infrastructure as a Service(**IaaS**)*

It delivers computer infrastructure that is virtualized platform as a service without buying software and servers. For example-IaaS providers include Amazon EC2 [7], GoGrid and Flexiscale [8].

- *Platform as a Service(**PaaS**)*

It allows application developers to host their services. Example:Google's App Engine, Amazon E2C, Microsoft Window Azure [9] and Force.com [10].

- *Software as a Service(**SaaS**)*

The application itself is given by service provider. Software can be used as a service over the internet without installing software on user's

computer. Example: User email -Gmail, Yahoo, User Picture- Picasa, Salesforce.com[10].

Cloud service model which are discussed above, shown in figure 2.

3.   CLOUD COMPUTING ARCHITECTURE

In cloud computing resources are retrieved from the internet through web-based tools and applications. This allows the users to work remotely because the cloud can be used as "Internet". Therefore it is not processed as traditional outsourcing. It is also called Massive Computing. In this, the allocation of the application must be dynamic. There is no need to install any type of hardware and software. The target of cloud computing is to permit the users to access the data from all the technologies, applications without any deep knowledge about them [11]. In cloud computing architecture, there is no need of high power computer to run web-based applications. In cloud computing architecture, the applications, data, and services all are stored in the cloud via the internet and run the applications and stored data by delivering the software resources as on-demand services. Now we are describing different modes of cloud computing as follows:
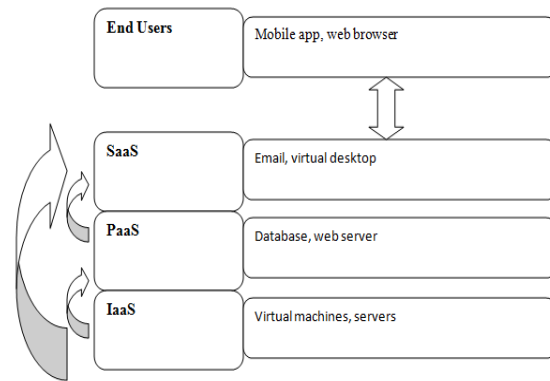

Fig.2: Cloud service computing models

A. Public Cloud

It can be shared by various organizations. Example- Amazon, Google. Public Computing application storage are made available to all organization. This is also known as "External Cloud". Resources are dynamically distributed over the internet via web services.

B. Private Cloud

This Cloud infrastructure is dedicated to a specific organization and cannot be shared with other organization. Private cloud is more secure and more

expensive as compare to public cloud and other clouding modes.

C. Hybrid Cloud

It is combination of Public and Private Cloud and also composed of more than two clouding modes. Organization may host critical applications on public cloud or private cloud that's totally depending on demands. In a hybrid cloud, part of the applications, service infrastructure processedin private clouds while the remaining partprocessed in public clouds [1, 3]. And modes of cloud computing are shown below.
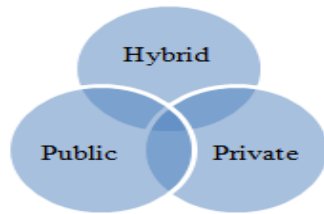

Fig.3 Modes of cloud computing

Cloud computing architecture is also called as "Layered computing model" [1]. Cloud computing architecture can be divided into four layers that is hardware layer, infrastructure layer, platform layer, application layer that are shown in fig.4:
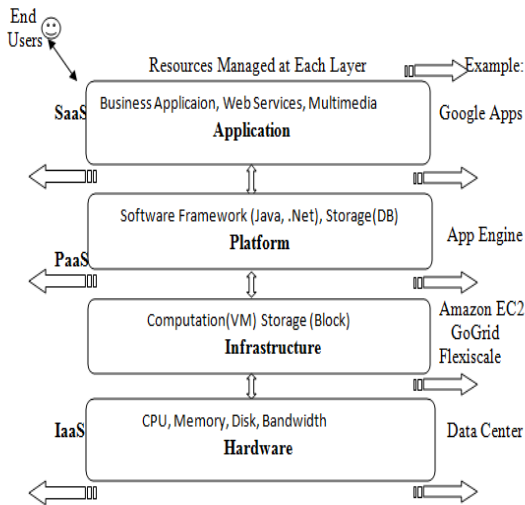
The description of each layer is defined as follows:

Fig.4 Cloud Computing Architecture

- *Hardware Layer*

Physical resources of the cloud are managed by it. Controlling physical servers, switches, routers, power system is the responsibility of hardware layer. The implementation of the hardware layer is provided in data center. This data center contains several servers that are interconnected through routers and switches. Some issues occur in hardware layer including fault tolerance, hardware configuration, traffic management and resources management.

- *Infrastructure Layer*

It is also called "Virtualization layer". It is an essential aspect of cloud computing. Infrastructure layer based on key features such as dynamic resource assignment that is available through virtualization technology. Infrastructure layer makes the collection of computing and storage resources and partition the physical resources by usingvirtualization techniques. Example:- Xen[12], VMware[13].

- *Platform Layer*

Platform Layer is made up of operating system and application framework. It is built on top of the infrastructure layer. The main concept of platform layer is to minimize the overhead of deploying application directly into VM containers. For example GoogleApp Engine operates at the platform layer to allocate API supports for implementing data storage of different web application.

- *Application Layer*

It is built on top level of cloud architecture. It is composed of actual cloud application. Cloud applications have essential features to achieve better performance, lower operating cost, availability and scalability.

Thus this architecture is more modular than other architecture (traditional architecture). Loosely coupled concepts are used in each layer. This architecture permit cloud computing to carry a wide range of application requirements while reducing overall overhead.

4. CHALLENGES IN CLOUD COMPUTING

Cloud computing is composed of several applications, infrastructure and platforms which perform different operations [14]. So there are several security issues for cloud computing since it consists of technologies like operating systems, networks, databases, memory management etc. For smooth transition there must be a well understanding of challenges and benefits. The acceptance of cloud computing have many issues. Some of them, which we have studied from various resources on the internet, are listed below.

A. Security and Privacy

The security of data is major concern in cloud computing. Since the data in cloud computing is outsource to a third party, it becomes difficult to continued data integrity and privacy. It must assures that services are easily available and are safe and

secure. Privacy is also provided to secure the data. There are two types of security threats i.e. internal and external. In external threat, attack is caused by various users and organization that do not have direct access to cloud. Internal threat is "well-known security risk". In this, a user or organization have direct access to the cloud and cause any type of attack within the cloud. Several data storage security techniques are implemented in cloud computing such as implicit storage security, identify encryption and decryption scheme, TPA, secure storage protocol etc[3].

B. Powered management issues

It is also a concerning issue in cloud computing in 2006, it is reported that US has consumed more than 1.5% of the total energy generated in 2006 and it is estimated that percentage might increase up to 18%[15]. The focus should not only to reduce the energy cost but also on maintaining environment standards and to meet government regulations. Building energy efficient data center has gamed much attention. Two other ways for reducing power consumption are energy aware job scheduling and server consolidation[15]. The challenge is to maintain a balance between application performance and energy savings. Few researches have been started to find solution for application performance and energy consumption in cloud computing environment[16].

C. Liability

Another security challenge is liability that is incorrect behavior in terms of wrong results. For example: if data get leaks, it would be difficult to determine where fault occurs that is either at client side or at server side.

D. Performance

Performance is one of the biggest issue in cloud computing. Performance is generally effected by the factors such as limited bandwidth, low disk space, CPU speed etc. Generally user wants to access the data from both public as well as private cloud which becomes challenging for data intensive application to provide proper resources and results in loss of customers, end of services etc[17].

E. Difficulty in moving application

It is not easy to migrate the data from a source to cloud computing environment or even with in cloud computing platforms as different cloud providers have different application architectures.

F. Dependency on internet

Cloud computing is fully dependent on the availability, quality, speed and performance of internet because internet act as a medium of transmission between users and service provider [18].

G. Data confidentiality

Only authorized users can access the protective data. Because of the increase in number of users and applications, it leads to an increase number of access points. Hence, data become accessible to more users resulting into security issues. Client should have components for ensuring that their data is secure in an untrusted cloud. By using cryptographic methods, a client can check the integrity of data by adding hash in local memory and rechecking the hash of receive data, thus authenticate server response by comparing the hash values. For large data set, hash trees are implemented. Recent research shows the efficiency of cryptographic method[19].

5. CHALLENGES IN CLOUD COMPUTING

Cloud computing has gained much attention in providing services over the internet. It provides greater flexibility, reliability, on demand services to the end users. It is an influential paradigm for various organizations. It provides all the required resources at a one place in a very cheap way. It is easy to access the resources from longer distance. But sharing data through cloud is not that safe. In this paper we have discussed the concepts and challenges that can occur in cloud computing. We hope that further researches would make groundbreaking developments in this field.

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