Cloud Computing: A Concept of Computing Resources on Internet and its Designing

Sudeep Srivastava*, Ruchi Garg**
**Software Project Programmer, IIC Delhi University South Campus*
***Associate Professor, Global Institute of Information Technology*
sudeep@ssoftware. in, mca2005sudeepsri@gmail. com, ruchibhartigarg@gmail. com

Abstract: Cloud computing has been developed as a new model for hosting and transporting services over the Internet. Cloud computing is beautiful to industry owners as it eliminates the necessity for employers to plan in advance, and lets enterprises to begin with small scale and increase the supply only when there is a escalation in demand. However, regardless of the fact that cloud computing presents huge openings to the IT industry, the growth of this technology is currently at its beginning, as many issues still exists to be addressed. In this paper, an analysis of cloud computing is presented to stress on its key ideas, architectural principles, and state of the art operation as well as research challenges. This paper intends to provide a better perceptive of design concepts of cloud computing and to recognize important research directions in this increasingly upcoming area.

Keywords-*Cloud Computing, Data Centers, Virtualization, Internet, Research challenges, PaaS, IaaS, SaaS*

I. INTRODUCTION

With the developments in the areas of processing, storage technologies and the accomplishment of the Internet, online computing capitals have become cheaper, more powerful and more universally available than previous scenarios. This technological drift has enabled the ideas of a new computing model, which is mutually know as Cloud Computing, in which resources like CPU, storage space and applications are offered as general functions that can be rented and used by users through the Internet as per need.

In this computing background, the service provider's role which is traditional is divided into two, one is the infrastructure providers who look after platforms of cloud and leases out the resources according to a usage based costing model, and second is service providers, who rent capitals from one or many organization providers to serve the end users. The development of cloud computing has made a wonderful impact on the IT industry over the past few years, where large businesses like Google, and Microsoft strive to deliver more controlling, reliable and cost efficient cloud plans, and business seek to restructure their business models to add benefit from this new model. Actually, cloud computing provides several compelling features that make it attractive to business owners [3], as given below.

A. *No direct investment:* Cloud computing uses a pay when user goes for a costing model. A package supplier does not need to capitalize in the setup for getting benefits of cloud computing. The user may simply rent out properties of the cloud according to the need and will pay according to the usage.

B. *Dropping functioning charge:* Capitals in a cloud location can be fast allocated and de-allocated on demand of the user. Henceforth, a package supplier no longer needs to delivery capacities according to the maximum load. This provides huge savings as compare to the resources which are released to save the operational costs when package request is low.

C. *Extremely scalable:* Infrastructure providers pool, large amount of capitals from data centers and make them easily available. A package supplier can simply increase its services to

provide large volumes for handling quick increase in package demands.

This model is sometimes called surge computing.

D. *Easy-going approach:* Web based technologies are used to host the cloud services. Then, they are easily available through a variability of procedures (devices) compatible to Internet connections. Such devices includes desktop, laptop computers, along with Mobile devices like Cell Phone [3].

E. *Dropping business risks and protection over heads: W*ith the facility of outsource the services to the cloud, a service provider may shift its business risks like hardware and software crashed (many others) to infrastructure providers. These providers usually equipped with better expertise and able to manage such risks in skillful manner. Also, such providers can slash down the maintenance of the hardware and also costs related to the training of the staff.

However, the concept and practical implementation of cloud computing has shown humungous offerings in IT industry, along with lots of exceptional challenges which need to be judiciously attended. This paper present a research of cloud computing, with great emphasis on its basic concepts, principles related to its architecture, advanced implementations as well as research challenges. The intention is to offer a better clarity with respect to challenges related to design of cloud computing and to spot main research directions on this upcoming concept.

This paper has been organized in seven sections. section II covers a summary of cloud computing and associate it with other associated technologies. section III, covers the planning of cloud computing architecture and its design philosophies. The key features and types of cloud computing are covered in section IV & Section V covers the research of lucrative products along with current technologies which are required for this computing. Section VI, covers the current research topics in cloud computing. At last, the paper concludes in Section VII.

II. OVERVIEW

This section covers an overview of cloud computing, including its meaning and a comparison with related thoughts.

The main thought of processes for cloud computing is not new. In 1960s anned that computing facilities would be carried to the overall public like utility. The word "cloud" has also been used in several perspectives like in 1990s it is used in the description of large ATM networks[2]. Since then, the word cloud computing has been used mostly as a marketing word in a diversity of contexts to represent many unlike ideas. Certainly, the lack of a normal definition of cloud computing has made not only sell hypes, but also a fair amount of doubt and confusion. In this paper, we adopt the explanation of cloud computing suggested by "The National Institute of Standards & Technology"as it covers, in our view, all the essential parts of cloud computing.

"*The Model of Cloud Computing for allowing opportune, on demand network door to a public pool of configurable computing resources like networks, servers, storage, applications, and services which can be quickly provisioned and freed with less management effort or service provider interaction. "*

The main reason for the reality of different observations of cloud computing is that computing, distinct other technical terms, is not a new technology, but somewhat a new processes model that brings composed a set of current technologies to run business in a different way. Really, most of the technologies used by cloud computing, such as virtualization and utility based costing, are not at all new. In its place, cloud computing powers these current technologies to chance the technological and financial requirements of current demand for IT [2].

Cloud computing is frequently likened to the some technologies, each of which shares positive characteristics with this computing:

A. *Grid Computing:* Grid computing is a spread-computing example that organizes networked capitals to complete a joint computational objective. The growth of this computing was first driven by technical applications, which requires high level of computations. The concept of Cloud computing is also somewhat similar to this computing in that it also works distributed resources to complete application level goals. In actual, cloud computing goes a step further by leveraging IT at multiple levels like hardware and application software to implement the sharing of resources and also provisions for dynamic resources[2][5].

B. *Utility Computing:* It designates the model of delivering capitals on request and to charge the customers on the basis of their actual usage rather than on fixed rate basis. It can be supposed as an understanding of utility computing. It accepts a utility based pricing arrangement completely for economic reasons. By providing recourses on demand and charging them according to the use; service providers actually maximizes the resource utilization and minimize its working costs.

C. *Virtualization*: Virtualization is a technology that summaries the basic points of physical hardware and provides virtualized capitals for high-end applications. A virtualized server is actually called a virtual machine (VM). It the basis of cloud computing, as it provides the skill of combining computing capitals from clusters of servers and dynamically allotting or recasting virtual capitals to applications on demand.

III. CLOUD COMPUTING DESIGN

This section defines the designing, business & various setup models of cloud computing [10].

A. Layer Model

Normally, the design of a cloud-computing environment can be separated into 4 layers: as in Fig. 1. We'll describe them in detail:

1) *The hardware layer*: The responsibility of this layer is to look after the physical capitals of the cloud, with servers, network routers, network switches, power supply and AC systems. In habit, this layer is normally designed in place at data centers. Data center commonly covers thousands of servers that are pleased in racks and organized through network switches, network routers or other network fabrics. Normal issues at this layer include hardware configuration, responsibility acceptance, network traffic management, power supply and AC resource management [10].

2) *Infrastructure/Virtualization layer:* the infrastructure/virtualization layer designs a way of storage and computing capitals by dividing the physical capitals using virtualization machineries such as KVM and others machineries. This layer is a necessary module of cloud computing, because many key features, such as dynamic supply transfer, are only be available by these machineries.

3) *Platform layer:* Made on top of the setup layer, the platform layer consists of computer operating systems & application frameworks. The use of this layer is to reduce the load of hosting applications directly into VM containers. Like, Google App at this layer to provide API support for managing storage, database and business logic of normal web applications.

4) *Application layer:* At the Top of the hierarchy, this layer contains of the real cloud applications. Unlike from old-style applications, cloud applications can influence the automatic-scaling feature to reach better performance, accessibility and less operating cost.

Related to old-style service hosting environments like dedicated server farms, the design of cloud computing is more flexible. All layers are lightly

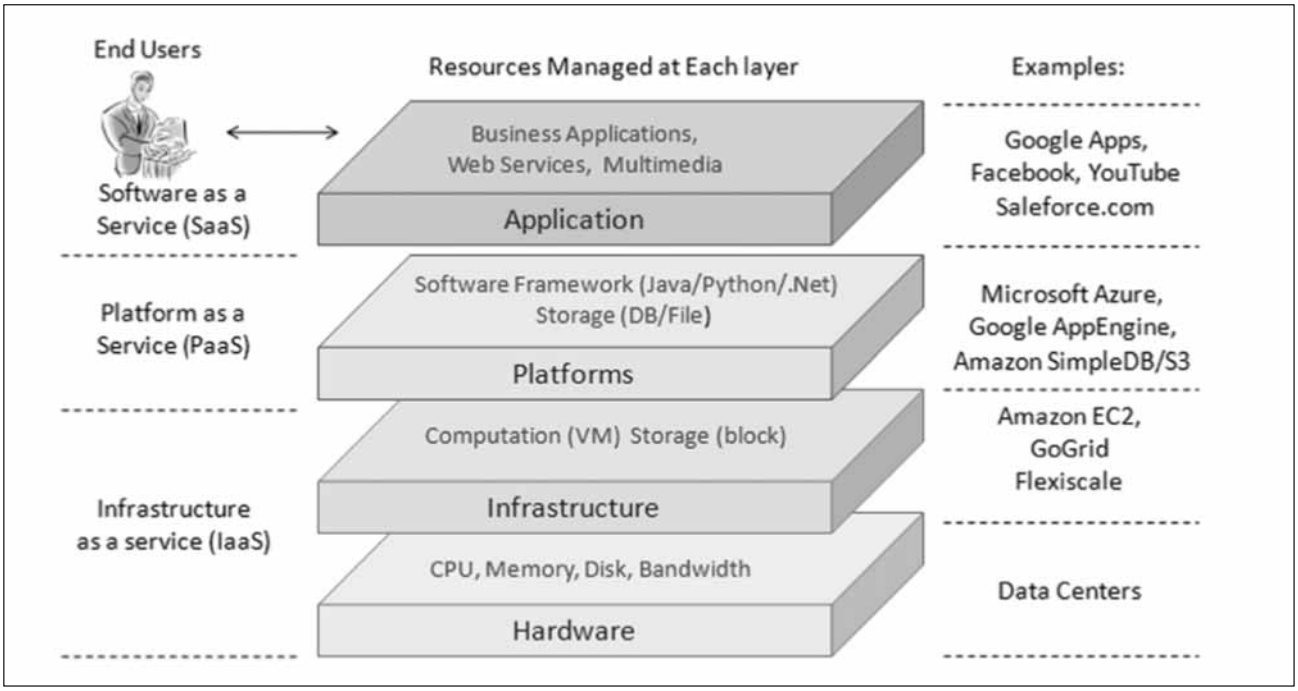

Fig. 1 Cloud computing's Layer model

joined with the layers given above and below, allowing each layer to change separately. This resembles with the design of the network OSI model for network management. The designing modularity permits cloud computing to support a wide range of application necessities while dropping management and upkeep overhead.

B. Business model

Cloud computing services are a service-driven business model. In other words, hardware and platform level capitals are provided as facilities on-demand basis. Theoretically, every layer of the design defined in the above section can be applied as a service to the layer above. But, in practice, clouds proposal services that can be assembled into three categories: Software as a Service also called SaaS, Platform as a Service also called PaaS, and Infrastructure as a Service also called IaaS [4] [10].

1) *Infrastructure as a Service*: IaaS refers to on request provisioning of infrastructural capitals, habitually in terms of VMs. The cloud proprietor who offers IaaS is called an IaaS supplier like Go Grid, EC2[10] etc.

2) *Platform as a Service:* PaaS refers to offering platform layer capitals, including computer operating system support and software development frameworkslike Google App, MS Windows Azure [4].

3) *Software as a Service*: SaaS refers to offering on request applications over the Internet like Salesforce. com etc.

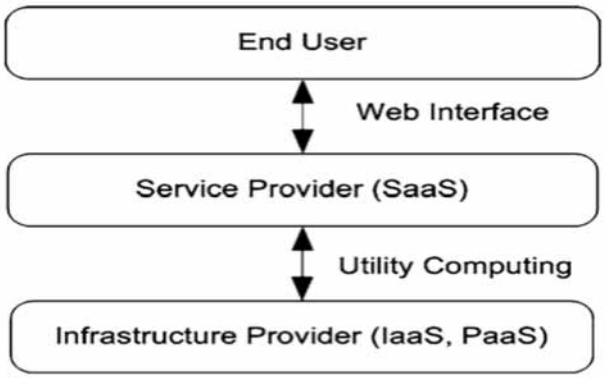

Fig. 2 Business Model

Figure 2 depicts the business model of cloud computing as cloud computing is a layered architecture it is possible that a PaaS provider executes its cloud on the top of cloud of an IaaS provider. But, in the current scenario, IaaS and

PaaS providers may be the parts of the same organization (e. g. , Google and Sales force) [4]. Hence these providers are usually called the infrastructure providers or cloud providers.

C. Type Clouds

There are many issues to consider before choosing an enterprise application on cloud environment. For example, some providers may only be interested in low operational cost, while reliability and security may be concerns of others. Due to this, there are different types of clouds according to it own benefits and drawbacks [4] [10].

1) *Public clouds:* Public cloud is that in which service providers provide resources as services to the public. Such a cloud offers various benefits to service providers, as there is no initial investment on laying the infrastructure or any risks to infrastructure providers [4].

2) *Private clouds: T*his type can also be known as internal cloud. They are designed exclusively to be used by people of a single organization. It can be designed, managed and maintained by the organization itself or could be through some external provider. It offers the maximum of control on many key features like performance, reliability security, [4]

3) *Hybrid clouds:* The combination of public and private cloud models is called Hybrid cloud. This cloud manages to be free from the restraints of each approach (Public and private cloud). In this, some portion of service infrastructure executes in private clouds whereas the rest of the part executes in public cloud. This cloud is considered as more flexible than both public and private clouds [4].

4) *Virtual Private Cloud:* Generally termed VPN can be considered as a secondary solution for providing remedies to the problems of both public and private cloud. VPC executes on top of public cloud. VPC delivers seamless change from an exclusive service setup to a cloud-based setup, owing to the virtualized network layer [4].

IV. CHARACTERISTICS OF CLOUD COMPUTING

Cloud computing delivers numerous significant features that are different from old-style service of computing, which summarized below:

A. *Multi Tenancy:* In a cloud world, services kept by numerous suppliers are co-located in a one data center. The processes performance and administration issues of these services are public among service providers and the setup provider. The layered design of cloud computing provides a natural division of accountabilities: the proprietor of each layer only needs to emphasis on the exact purposes related with this layer. Yet, multi tenancy also introduces problems in understanding and managing the contacts among various investors.

B. *Shared resource pooling*: Many computing resources are offered by providers which will cater the need of consumers. Like dynamic resource task ability delivers much flexibility to setup providers for handling their own resource usage and working costs.

C. *Geo distribution &global network access:* Clouds are generally available through the Internet & use the Internet as a package delivery network. Therefore any sort of devices having connectivity of Internet like mobile phones, laptops etc are able to access cloud services.

D. *Service oriented:* As already mentioned, cloud computing follows an operating model which is service-driven. Hence it lays a sturdy emphasis on service management. In a cloud, each IaaS, PaaS and SaaS provider offers its services according to the Service Level Agreement (SLA) which can be negotiated with the customers to cater their need.

E. *Dynamic resource provisioning:* As compared to the traditional models which has provisions for providing resources according to peak demand, DRP permits its service providers to acquire resources based on the current demand of users, which will lower down the operational cost.

F. *Auto Organizing:* Since resources can be allocated or de-allocated on request, service providers are authorized to manage their store consumption according to their own needs. Also, the automatic store management feature profits high speed that enables package suppliers to respond quickly to fast changes in package demand like the flash crowd effect.

G. *Utility Based Costing:* This computing employs a pay per use costing model. The exact costing scheme may vary from service to service. Like, SaaS provider may rent a VM from an IaaS provider on a per hour basis. On the other side, SaaS provider that provides on request customer relationship management or CRM may charge its customers based on the number of clients it helps Utility based costing lowers package operating cost as it charges customers on a per use basis.

V. STATE OF THE ART

In this section, we present the State of the Art applications of cloud computing. We first define the key machineries currently used for cloud computing.

A. Architectural design of data centers

A center which possesses large number of devices say in thousands like servers, switches, routers etc where all computations power and storage is done , is central to cloud computing is called data center. The criticality in this is its proper planning because it will directly affect the performance of the applications and their throughput. Also the features like scalability and resiliency are to be handled carefully [1].

Presently, network architecture design follows a layered approach. This approach has been tested in some of the largest deployed data centers. The basic layers of a data center are core, aggregation, and access layers, as shown in fig. 3. The access layer is where the servers in racks physically connect to the network[1]. Each rack consists of around 20 to 40 servers, each being connected to an access switch with a 1 Gbps link. Access switches usually connect to two aggregation switches for redundancy with 10 Gbps links.

Functions like domain service, location service and server load balancing are few functions which are provided by aggregation layer. Connectivity

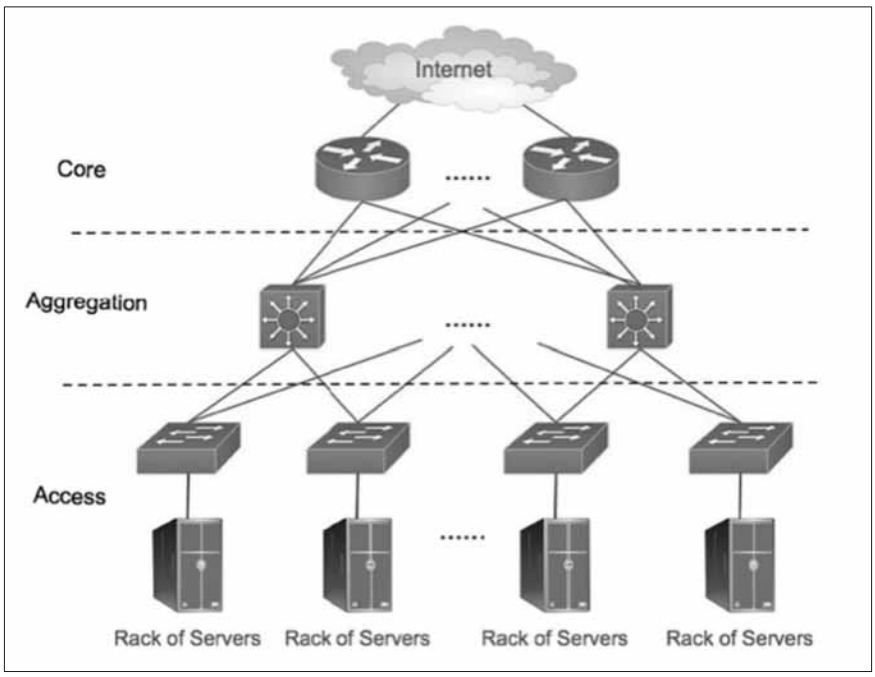

Fig. 3 Basic layered design of data center network setup

to the multiple aggregation switches is provided by core layer. It also provides a resilient routed fabric failure tolerant. The traffic in and out of the data center is managed by core routers.

The layered network infrastructure can be further elaborated to cater the need of particular business challenges depending upon the proposed business solutions.

Following objectives should meet the design of data center network architecture

1) *Uniform High capacity:* The traffic flow from one server to another should be limited by the fixed size on the network boundary path of the servers (sender and receiver). The assigning servers to a package should be not being dependent on the network topology.

2) *Free VM migration:* With the help of concept of virtualization, the entire VM state can be transmitted across the network from one machine to another. A service which is hosted by cloud computing can migrate VMs for statistical multiplexing or dynamically changing communication patterns to achieve high bandwidth for tightly coupled hosts.

3) *Resiliency:* Failures will be joint at rule. The network setup must be fault accepting against various types of server failures, link outages, or server rack failures.

4) *Scalability:* The network setup must be able to measure to a big number of servers and allow for incremental growth.

5) *Backward Compatibility:* The network setup should be backward compatible with network switches &network routers running Ethernet & IP, because existing data centers have usually leveraged commodity Ethernet and IP based devices, they should also be used in the new design.

B. Cloud's Distributed application framework

HTTP based applications usually conform to some web application framework such as Java EE. In current data center settings, groups of servers are also used for calculation and data severe jobs such as financial trend analysis, or film animation.

Map-Reduce is a software framework hosted by Google to support distributed computing on big data sets on groups of computers. Map-Reduce contains of one Master, to which client requests submit Map-Reduce jobs. The master pushes work out to available task nodes in the data center, determined to keep the tasks as close to the data as possible. It knows which node contains the data, and which other hosts are close. If the task cannot be hosted on the node where the data is stored, importance is given to nodes in the same stand. In this way, network traffic on the main support is reduced, which also helps to improve output, as the support is usually the block [6].

The open source Hadoop Map-Reduce project is inspired by Google's work. Now, many organizations are using Hadoop Map-Reduce to run large data intensive calculations [6].

VI. RESEARCH CHALLENGES

The concept and technology of cloud computing has been adopted greatly by the industry, still the research on cloud computing is in its early stage. There are several issues present which are not yet fully addressed, on the other side new problems and challenges keep coming from industry applications. Some of the of the challenging research issues in cloud computing are summarized in this section.

A. Server Consolidation

In order to utilize the resources to its maximum along with minimal energy consumption, server consolidation is considered as a very effective approach. For doing this, Live VM migration technology is used to consolidate VMs which resides on many servers which are utilized below capacity onto a single server, so that the remaining servers can be set in a state of energy-saving. The

problem of optimally joining servers in a data center is often expressed as a irregular of the vector bin packing problem, which is an NP hard optimization problematic. Various heuristics have been proposed for this problem. Additionally, dependencies among VMs, such as communication requirements, have also been considered recently.

In any case, server consolidation activities should not degrade the performance of the application.

B. Energy Management

One more major issue in cloud computing is to improve the energy efficiency. Almost 53% of the total operational cost in incurred due to power consumption in data centers. Hence to reduce energy consumption should be a major concern for infrastructure providers.

Designing energy-efficient data centers has recently received considerable attention. This problem can be approached from several directions. For example, energy- efficient hardware architecture that enables slowing down CPU speeds and turning off partial hardware components has become commonplace. Energy-aware job scheduling and server consolidation are two other ways to reduce power consumption by turning off unused machines.

C. Traffic Management and Analysis

There is a huge movement of data in data centers. Many web applications require analysis of that data for various decisive inputs. They will really be helpful in managements' planning decisions. Currently, there is not much work on measurement and analysis of data center traffic.

D. Data Security

Another important area of concern in cloud is Data security. As service providers do not have access to the physical security system of data centers, they have to rely on the infrastructure provider for having data security. The service providers can only specify the security settings remotely, with- out knowing whether security features are fully implemented or not, even in virtual private cloud. The objectives which any infrastructure provider, should achieve are (1) privacy, to secure data access (2) auditability, for showing whether security setting of applications has been tampered or not. Privacy is usually accomplished using cryptographic procedures, while auditability can be accomplished using remote attestation methods.

E. Software Frameworks

Cloud computing caters large number of data intensive applications. These applications influence MapReduce frameworks for example Hadoop for scalable and fault-tolerant data processing applications. The consumption of resources and performance of MapReduce job is highly dependent on the type of the application. For example, Hadoop tasks such as, sort requires large input output where as grip needs large of CPU resources. Further to add to this, the VM allocated to each Hadoop node may have mixed features. For example, the bandwidth availability of a VM may be dependent on other VMs which are allocated on the same server[6] [10].

F. Storage Technologies & Data Management

The Software frameworks for example Map-Reduce and its various implementations such as Hadoop and Dryad are especially designed to handle data intensive tasks in distributed processing [6]. As we have mentioned, such frameworks normally operates on Internet scale file systems such as GFS and HDFS. These file systems are different from traditional distributed file systems with respect to storage ways, data access techniques and application-programming interface [10].

VII. CONCLUSION

Cloud computing is developing as a new model for hosting services over the Internet. The growth of computing is fast changing the landscape of

IT, and finally rotating the long held potential of helpful computing into a reality.

However, despite the important profits open by cloud technology, the up-to-date technologies are not developed sufficient to understand its full prospective. Some of the key challenges in this domain, along with automatic resource provisioning, power supply management and data security management, are only first to obtain attention from the research group. Then, we believe there is still wonderful chance for researchers to make revolutionary assistances in this field, and bring important impact to their growth in the business.

In this paper, we have examined the state of the art of cloud computing, and tried to cover its vital concepts, architectural designs, prominent features, key skills as well as research instructions. As the growth of cloud computing technology is still in its initial stage, we hope our work has covered the design challenges of cloud computing, and it will cater a better thought fulness regarding further research in this area.

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