

# Cloud Computing: Technical Challenges and CloudSim Functionalities

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**Abstract:** *The rapid development in internet era is continuous; big organizations and individuals are finding the means that can reduce their cost of communication, storage and computing. One of these, Cloud computing is an emerging technology that can deliver reliable, secure, fault-tolerant, sustainable, and scalable services. Cloud computing present's software, infrastructure, or platform as services (SaaS, IaaS, and PaaS). For example, instead of storing software applications and data locally on a personal computer, the software applications and data are stored on remote servers and accessed through a connection to the internet. The services offered by Cloud Computing over the Internet are rapidly changing the way we use computers. Companies that have built large data centers to offer these services include Microsoft, Amazon, Google, and Yahoo. In these days, More than 70 percent of 1000 companies will pay for some cloud computing service, and more than 20 percent of them will pay for cloud computing infrastructure. In this paper, we will discuss all aspects of cloud computing like concepts, definition, types, characteristics, benefits, and identify the top technical and non-technical challenges of cloud computing also focusing on CloudSim and its functionality in this field.*

**Keywords:** Cloud Computing, SaaS, IaaS, PaaS, Technical Challenges, CloudSim.

## 1. Cloud Computing: History and Definition

Cloud computing is a delivery model of computing and storage capacity as a service to a community of end-users [1]. The name refers to cloud-shaped symbol as an abstraction for the complex infrastructure it contains in system. The concept or fundamental of cloud computing was introduced in 1960s by John McCarthy. His thought was that "computation may someday be organized as a public utility [2]". Also the features of cloud computing were appeared for the first time in 1966 by Douglas Parkhill in his book "The challenge of the computer utility [2]". Cloud computing term comes from telecommunication world, where telecommunication companies began using VPN services with QoS and much lower cost. Cloud computing removes IT trend from desktop and portable PCs into large data centers. National institute of standards and technology (NIST) defines cloud computing as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., servers, networks, storage applications and services) that can be rapidly provisioned and released with minimal management efforts or service provider interaction [3]". Here, NIST express that cloud computing is a new delivery model for computing infrastructure, services and information using many existing technologies that have been harnessed and made available by the cloud service provider's (CSP's). With cloud computing, CSP's use the internet infrastructure to allow communication between client side and server side services/applications and offer the customer/user a pay-per-use model of the CSP's computing resources and infrastructures. The cloud-computing goal is to make better using of distributed

resources and combine them to achieve higher throughput and solve large-scale computation problems. Cloud computing can deal with virtualization, scalability, interoperability, quality of service and models of the cloud that called private, public and hybrid. Sometimes ago, Cloud computing was a buzz term and controversial between many of IT professionals. In 2012, cloud-computing term stops being a buzzword and becomes a part of our plan today. Many of industries and many of biggest corporations such as Google, Amazon, Microsoft and Salesforce.com pushing the utilization of cloud technology and more businesses are staring to understand the cloud with some touting it to be the fifth generation of computing [4].

## 2. Cloud Computing Characteristics

Cloud computing has a variety of characteristics, as shown below [5]:

### 2.1 On-demand self-service

This characteristic enables users to use cloud-computing resources without any interconnection between them and the provider. Therefore, the lack of human interaction can provide efficiency and saving cost for both users and providers.

### 2.2 Broad network access

Cloud computing need high bandwidth communication links to provide a large pool of IT resources. So that, many organization use Tier 3 architecture or Tier 2 architecture to connect a variety of cloud computing platforms such as laptops, printers, mobile phones and PDAs to the WAN

using standards-based APIs ( for example, ones based on HTTP ).

### 2.3 Location Independent Resource Pooling

The cloud providers are pooling to serve multiple consumers using a multi-tenant model. According to consumer demand, physical and virtual resources dynamically assigned and reassigned. However, these resources can be located in wide geographic locations physically and assign it virtually. Resources can be included storage, processing, memory, network, bandwidth, and virtual machines.

### 2.4 Measured service

The monitoring of cloud resources amounts can be done automatically. Cloud system can automatically control and optimize resource use by using a metering capability at some level of abstraction appropriate to the type of service like storage, processing, bandwidth, and active user accounts. By providing transparency, resource usage can be controlled and monitored for provider and consumer. In addition, the user only pays for resources they consume and are always made aware of any discrepancies, spikes or abnormal behavior regarding resources

### 2.5 Rapid Elasticity

Users can rapidly increase and decrease their computing resources as needed, this is often achieved automatically, which gives the consumer impression that resources are infinite and that the application can always cope when in demand. When resources are no longer needed, they are relinquished back into the resource pool.

## 3. Cloud Computing Service Models

Cloud computing delivers the characteristics that remembered before through three main services that have come to define cloud computing and how the end users can access their resources and services. Together these three services form the cloud-computing stack shown below [6]:

### 3.1 Cloud software as a service (SaaS)

Offering to the users an easier way to access many of their standard business applications and services such as email and word processing packages etc., by allowing users to access these programs through the internet, there is no need to install and run the special software on your computer if you use the SaaS. Instead of buying the software at a relative higher price, you just follow the pay-per-use pattern, which can reduce you total cost. This allows businesses to save money, as it removes licensing fees and they only pay for what they use and when they use. It also removes the need to upgrade software packages as the cloud service provider does this automatically so the end user will always be up-to-date. One of the greatest benefits of SaaS is that the user can access their work and services from anywhere in the world

where they can connect to the Internet. Examples of SaaS today are Google's Gmail, Microsoft's Office Live.

### 3.2 Cloud Platform as a service (PaaS)

It is a set of cloud-delivered services that provide an environment for application development, management, deployment, and integration in the cloud. This service is tailored towards software developers, it allows new software solutions to be developed and even existing solutions to be extended without the developer having the hassle of having all the software development kits (SDK's) and infrastructure. Many CSP's are that offer PaaS have many web-based tools to decrease development time and reduce costs for developers such as version control, agile and lifecycle planning etc. There are many examples of PaaS today such as Google's App Engine, Amazon's EC2 and Microsoft's Azure platform.

### 3.3 Cloud Infrastructure as a service (IaaS)

It is known for providing computational and storage infrastructure in a centralized, location-transparent service. The infrastructure that is provided by the CSP includes storage, servers, bandwidth and network equipment, which includes software that monitors the use of the infrastructure and allows the user to only pay for what they use. Some of the most popular examples of IaaS today include Go Grid's Serve Path and Amazon's Elastic Compute Cloud (EC2).

## 4. Cloud Computing Types

There are four types of cloud as shown below:

### 4.1 Public Cloud

A Public Cloud is data center hardware and software run by third parties, e.g. Google and Amazon, which expose their services to companies and consumers via the Internet [7]. A Public Cloud is not restricted to a limited user base: it "...is made available in a pay-as-you-go manner to the general public" [7]. Thus, Clouds can address two type of customers: end either consumers on the B2C market or companies on the B2B market.

### 4.2 Community Cloud

Community cloud may be established where many organizations have similar requirements and seek to share infrastructure to gain some of benefits of cloud computing. With the costs spread over fewer users than a public cloud( but more than a single tenant ) this option is more expensive but may offer a higher level of privacy, security and/or policy compliance. Examples of community cloud include Google's "Gov Cloud".

### 4.3 Hybrid Cloud

Hybrid clouds combine public and private clouds and allow an organization to both run some applications on an internal cloud infrastructure and others in public clouds [8]. This way, companies can benefit from scalable IT resources offered by external cloud providers while keeping specific applications or data inside the firewall. A mixed cloud environment adds complexity regarding the distribution of applications across different environments, monitoring of the internal and external infrastructure involved, security and privacy, and may therefore not be suited for applications requiring complex databases or synchronization[8].

### 4.4 Private Cloud

The cloud infrastructure has been deployed, and is operated for a specific organization. The operation may be in-house or with a third party on the premises. A Private Cloud relies on virtualization of an organization's existing infrastructure [6], leading to benefits such as increased utilization. The key advantage of a Private Cloud is to gain all advantages of virtualization, while retaining full control over the infrastructure.

## 5. Cloud Computing Benefits

Below, are some of the possible benefits for those who offer cloud computing-based applications and services [9]:

### 5.1 Cost Savings

Companies can decrease their capital expenditures and using operational expenditures to increase their computing capabilities. This is a lower obstacle to entry and needs fewer in-house IT resources to provide system support.

### 5.2 Scalability/Flexibility

Companies can start with a simple deployment and grow to a large deployment, and then scale back if it is necessary. In addition, the flexibility of cloud computing permits companies to use additional resources at peak times, enabling them to gain satisfy with consumer demands.

### 5.3 Reliability

Services using multiple sites can support business continuity and disaster recovery with continuous availability.

### 5.4 Maintenance

Cloud service providers take responsibility of system maintenance, and access through APIs that do not require application installations onto PCs, in this way, take further reducing maintenance requirements.

### 5.5 Mobile Accessible

Mobile workers and labors have increased productivity due to systems accessible in an infrastructure available from any location.

## 6. Technical and Non-Technical Challenges for Cloud Computing

In this section, we offer a number of challenges to the growth of Cloud Computing paired with it is an opportunity. The first three are technical challenges to the adoption of Cloud Computing; the next five are technical challenges to the growth of Cloud Computing once it has been adopted, as shown below [9]:

### 6.1 Availability of Service

Availability means keep service continuously without any interruption or take the service off the air. The best solution is providing multiple Cloud providers for business continuity. Therefore, the failure by a single company will not take them off the air. There is another obstacle of availability, which is distributed denial of service (DDOS) attacks. Utility Computing can provide the solution to defend against DDOS by using Elasticity, Cloud Computing moves the attack path from the SaaS provider to the Utility computing provider and should have DDOS protection as a core component.

### 6.2 Data Lock-In

APIs for Cloud computing are still not in active standardization. By result, consumers cannot extract their data and programs from one site to another. The proposed solution is to standardize the APIs so that a SaaS developer can deploy data and services on multiple Cloud computing providers and the failure of one company will not take all copies of consumer data entirely. However, this will lead to flat the profits of Cloud computing providers. Nevertheless, standardization of APIs enables "Surge Computing" that will lead to run easily and take the heavy workloads.

### 6.3 Data Confidentiality and Auditability

We can ensure the data confidentiality by using well-understood technologies such as encrypted storage, Virtual Local Area Networks, firewalls, and packet filters. Auditability could be as additional layer beyond the virtualized guest OS and this can provide more security. Accommodate National Laws via Geographical Data Storage can be related to some of nations laws like Amazon services that physically on USA and Europe.

### 6.4 Data Transfer Bottlenecks

Data transfer a cross boundaries costs and consider as an important issue. One opportunity to overcome this obstacle is by ship disks. Therefore, the cheapest way to send many

data is to physically send disks or whole computers by delivery services. Another way can be Data Backup/Archival, lower WAN router Costs and Higher Bandwidth LAN Switches.

### 6.5 Performance Unpredictability

Many ways to overcome this challenge, which are improved virtual machine, support, flash memory, Gang Scheduling Virtual machines for high performance computing application.

### 6.6 Scalable Storage

This challenge is still opened for research problem to invent a scalable store with consideration of resource management for scalability, data durability, and high availability.

### 6.7 Bugs in Large Distributed Systems

One of the most challenges is to remove errors in these distributed systems. The proposed solution for this obstacle rely on virtual machines in Cloud computing.

## 7. CloudSim Toolkit and its functionalities

CloudSim is a new, general, and extensible simulation framework that allows modeling, simulation, and experimentation of emerging Cloud computing infrastructures and application services [7].

In Cloud Computing Case, The Simulations Tools like CloudSim [11] gives or offers significant benefits to the Customers and Providers. For Customers, It is allow them to test their services in controllable environment with free of cost and to check the performance before publishing to the real clouds. Meanwhile for Providers, allow them to check the kinds of leasing according to various prices and load. In addition, this will lead to optimize the resources access cost with improving the profits. Without these tools, both of the Customers and Providers must rely on imprecise evaluations, or on try-and-error approaches, these approaches may lead to inefficient services performance and reduce revenue generation. In addition, CloudSim helps researchers and industry-based developers to test the performance of a developed application service in a suitable and easy to setup environment. There are many advantages of using CloudSim for initial performance testing like:(i) time effectiveness: it takes very less effort and time to implement Cloud-based applications and (ii) flexibility: developers can easily model and test the performance of their applications and its services in heterogeneous environments( Microsoft Azure, Amazon EC2).

**CloudSim can help to overcome the Cloud computing challenges by providing many features likes:**

1. Support for modeling and simulation of large scale Cloud computing environments (including datacenters).

2. Support for simulation of network connections among the simulated system components.
3. A self-contained platform for modeling Clouds, service brokers, provisioning, and allocation policies.
4. Supporting for simulation of federated Cloud environment.
5. Support for creating and management of multiple, independent, and co-hosted virtualized services on a data center node.
6. In addition, support to switch between space-shared and time-shared allocation of processing cores to virtualized services.
7. Modeling and simulation of energy-aware of computation resources [10].

There are many difficulties that face testing and experimentation of Cloud Computing like demand for energy-efficient for IT technologies, demand timesaving, and controlling the evaluation of algorithms, applications, and policies before real cloud products. One of the suitable approaches to make all these difficulties as easy is the simulations tools. These tools can open an extension to check the hypothesis and reproduce tests. The object of this simulation tool is to offer an extensible framework that enables simulation, modeling, experimentation of Cloud computing infrastructures and application services. By using it, any interested researchers or organizations can focus on specific issues that want to get solution for it, without logging to the low-level infrastructures and services.

## 8. Conclusion

In this paper, we have expressed a new side of Cloud computing. We have also described its historical view, definition, characteristics, service models, cloud types, and some of challenges with CloudSim simulation tool with its features. Nevertheless, we still need to focus more into another side to complete view of this new phenomenon in computing world.

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