

# Exploring the Scope of Software Engineering in Cloud Computing

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## Abstract

This paper describes cloud computing in depth, a computing platform for the next generation of the Internet. The paper defines clouds along with it explains the benefits of cloud computing as well as outlines cloud types and its major horizons in field of software engineering. This paper also presents a small glance of a new perspective of cloud computing. The growth of cloud computing in the area of software engineering with the help of SAAS is described. This paper also includes the advantages and future scope of cloud computing.

## Keywords

Cloud Computing, Software Engineering, SAAS, Agile Methodology, Testing in Cloud

## I. Introduction

### A. Cloud Computing

Cloud computing can be defined as a new style of computing in which dynamically scalable and often virtualized resources are provided as a services over the Internet. Cloud computing has become a significant technology trend, and many experts expect that cloud computing will reshape Information Technology (IT) processes and the IT marketplace. With the cloud computing technology, users use a variety of devices, including PCs, laptops, smartphones, and PDAs to access programs, storage, and application-development platforms over the Internet, via services offered by cloud computing providers [1].

Cloud-based apps can be up and running in days or weeks, and they cost less. With a cloud app, you just open a browser, log in, customize the app, and start using it. Businesses are running all kinds of apps in the cloud, like customer relationship management (CRM), HR, accounting, and much more. Some of the world's largest companies moved their applications to the cloud with salesforce.com after rigorously testing the security and reliability of our infrastructure. As cloud computing grows in popularity, thousands of companies are simply rebranding their non-cloud products and services as "cloud computing." Always dig deeper when evaluating cloud offerings and keep in mind that if you have to buy and manage hardware and software, what you're looking at isn't really cloud computing but a false cloud [2].

Till date definition provided by National Institute of Standards and Technology (NIST) is the most appropriate and succinct definition covering all aspects of CC, thus it is considered as the standard definition and is as follows [3]:

*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's interaction.*

The NIST definition lists five essential characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured

service. It also lists three "service models" (software, platform and infrastructure), and four "deployment models" (private, community, public and hybrid) that together categorize ways to deliver cloud services.

## B. Cloud Computing Characteristics/Features:

Cloud computing has a variety of characteristics, with the main ones being [4].

### 1. Shared Infrastructure

Shared infrastructure uses a virtualized software model, enabling the sharing of physical services, storage, and networking capabilities. The cloud infrastructure, regardless of deployment model, seeks to make the most of the available infrastructure across a number of users.

### 2. Dynamic Provisioning

Dynamic provisioning allows for the provision of services based on current demand requirements. This is done automatically Using software automation, enabling the expansion and contraction of service capability, as needed. This dynamic scaling needs to be done while maintaining high levels of reliability and security.

### 3. Network Access

Network access needs to be accessed across the internet from a broad range of devices such as PCs, laptops, and mobile devices, using standards-based APIs (for example, ones based on HTTP). Deployments of services in the cloud include everything from using business applications to the latest application on the newest smart phones.

### 4. Managed Metering

Managed metering uses metering for managing, optimizing the service, to provide reporting and billing information. In this way, consumers are billed for services according to how much they have actually used during the billing period. In short, cloud computing allows for the sharing and scalable deployment of services, as needed, from almost any location, and for which the customer can be billed based on actual usage.

CC is equipped with many appealing features contributing towards its commercial applicability and popularity [5]. Some of them are as follows:

- On Demand Service
- Scalability
- No Initial Investment
- Elasticity
- Abstract Resource Sharing
- Ubiquitous Network Access

## II. Cloud Computing is Typically Classified in Two Ways [6]:

- Location of the cloud computing
- Type of services offered

## A. Location of the Cloud

Cloud computing is typically classified in the following ways:

### 1. Public Cloud

In Public cloud the computing infrastructure is hosted by the cloud vendor at the vendor's premises. The customer has no visibility and control over where the computing infrastructure is hosted. The computing infrastructure is shared between any organizations.

### 2. Private Cloud

The computing infrastructure is dedicated to a particular organization and not shared with other organizations. Some experts consider that private clouds are not real examples of cloud computing. Private clouds are more expensive and more secure when compared to public clouds.

Private clouds are of two types: On-premise private clouds and externally hosted private clouds. Externally hosted private clouds are also exclusively used by one organization, but are hosted by a third party specializing in cloud infrastructure. Externally hosted private clouds are cheaper than On-premise private clouds.

### 3. Hybrid Cloud

Organizations may host critical applications on private clouds and applications with relatively less security concerns on the public cloud. The usage of both private and public clouds together is called hybrid cloud. A related term is Cloud Bursting. In Cloud bursting organization use their own computing infrastructure for normal usage, but access the cloud for high/peak load requirements. This ensures that a sudden increase in computing requirement is handled gracefully.

### 4. Community Cloud

Involves sharing of computing infrastructure in between organizations of the same community. For example all Government organizations within the state of California may share computing infrastructure on the cloud to manage data related to citizens residing in California.

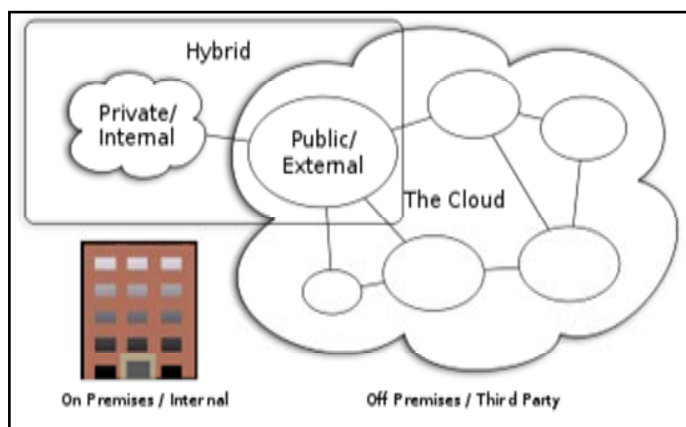


Fig. 1: Types of Cloud Computing [8]

## III. Classification Based Upon Service Provided

Based upon the services offered, clouds are classified in the following ways:

### A. Infrastructure as a Service (IaaS)

involves offering hardware related services using the principles of cloud computing. These could include some kind of storage services (database or disk storage) or virtual servers. Leading vendors that provide Infrastructure as a service are Amazon EC2,

Amazon S3, Rackspace Cloud Servers and Flexiscale.

### B. Platform as a Service (PaaS)

Involves offering a development platform on the cloud. Platforms provided by different vendors are typically not compatible. Typical players in PaaS are Google's Application Engine, Microsoft's Azure, Salesforce.com .

### C. Software as a service (SaaS)

Includes a complete software offering on the cloud. Users can access a software application hosted by the cloud vendor on pay-per-use basis. This is a well-established sector. The pioneer in this field has been Salesforce.com offering in the online Customer Relationship Management (CRM) space. Other examples are online email providers like Google's gmail and Microsoft's hotmail, Google docs and Microsoft's online version of office called BPOS (Business Productivity Online Standard Suite).

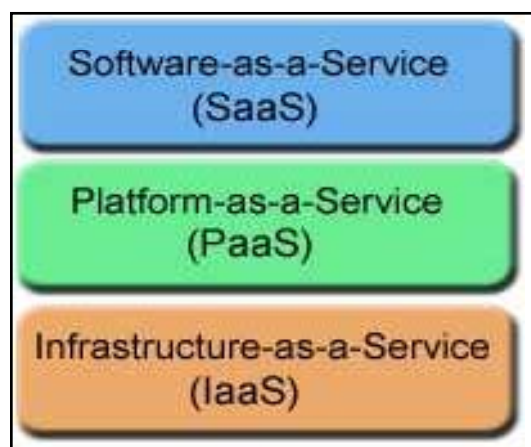


Fig. 2: Cloud Service Models

## Advantages:

Following are the advantages of cloud computing [7]:

1. Reduced Cost: Cloud technology is paid incrementally, saving organizations money.
2. Highly Automated: No longer do IT personnel need to worry about keeping software up to date.
3. Increased Storage: Organizations can store more data than on private computer systems.
4. Flexibility: Cloud computing offers much more flexibility than past computing methods.
5. More Mobility: Employees can access information wherever they are, rather than having to remain at their desks.
6. Allows IT to Shift Focus: No longer having to worry about constant server updates and other computing issues, government organizations will be free to concentrate on innovation.

## IV. Scope of Software Engineering in Cloud Computing Paradigm

Cloud computing is considered one of the fastest growing technology. Like the tree extends its branches in all directions, cloud computing has extended its horizons all over the areas of technology. Some of cloud computing effect can be seen in software engineering, big data, artificial intelligence and so on. Major effects can be seen according to deployment models of cloud computing. SAAS has a great influence in the field of software. Now days, building software, delivering software, testing software, etc have been given a new edge and a major

transformation. Looking in depth the scope of cloud computing in the field of software engineering is as follows:

### 1. Agile Methodology

Agile software development methodology is a conceptual framework of practices and principles to develop software faster, incrementally and to produce satisfied customer. Several agile software development methodologies have been suggested in the literature, like Extreme Programming, Scrum, Crystal Methodology and Mobile-D. All these methods adopt agile principles, such as iterative development, frequent and early delivery of working software, and simplicity as defined in Agile Manifesto [9].

There is a consensus that the current standard software process improvement frameworks such as CMM cannot be applied unmodified to small organizations [10]. While majority of the organizations who adopt or using the agile software development practices are categorized as small to Medium enterprises. In addition, they need to be tied to the business objectives as there is no mechanism for doing this yet with the current software process improvement models [11].

### 2. Cloud Testing

Software Testing in Cloud has three models [12].

#### (i). Testing as a Service (TaaS)

TaaS concept was initially introduced by Tieto in Denmark in 2009. Software testing as a Service (TaaS) is a model of software testing used to test an application as a service provided to customers across the Internet. By eliminating the need to test the application on the customer's own computer with testers on site, TaaS alleviates the customer's burden of installing and maintaining test environments, sourcing and (test) support. Using TaaS can also reduce the costs of testing, through less costly, on-demand pricing.

#### (ii). Testing Support as a Service (TSaaS)

To enhance testability of autonomic services, TSaaS was proposed so that each service will expose both production and test environment to external users. Test functions (such as specification, execution, configuration and reporting) are exposed as API services.

The technique was then migrated to the cloud platform [13], called TSaaS, so that services that are hosted on remote cloud platform can expose their test support APIs for partner providers. A self-test harness is developed to manage testing workflow and activities. It monitors changes or updates on hosted services, utilizes necessary infrastructure services, and invokes TSaaS supporting services to validate the changes. Test operations exposed as supporting services include test setup, input, assertions, and teardown operations. These services are provided for cloud partners during the development, testing and maintenance of tailor-made cloud applications and services. They can also be used for design, build, and deployment of automated tests across administrative domains.

#### (iii). Testing inside Cloud

Testing applications that are hosted and deployed in a cloud environment, or testing the cloud infrastructure itself.

### V. Conclusions and Future Scope

The basics of cloud have been illustrated but there are few interests and concerns in the cloud. There are interesting technical problems to solve according to technology side. There are essential usability,

stability, and reliability problems to solve according to view of service. There are many stories of problems with clouds, from data loss, to service interruption, to compromised sensitive data and lot more and on this the billions of new fast growing devices make it difficult to cope up with. It is possible that the wave of users, applications and demand will just wash over the cloud landscape, regardless of how robust they are [14]. If the cloud providers are too slow to provide safe, secure, reliable data storage and application services, they may miss one of the greatest opportunities of this century. The issues that are highlighted in this paper will be a hot spot for researchers in future. Areas like security, Load balancing, Software Agile Methodology, Testing the Cloud and Standardization will be the major research topics.

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