A basic Review on Cloud Testing

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Abstract - *With the rapid development of computing hardware, web programming, high-speed network distributed and parallel computing and other technologies, cloud computing has recently emerged as a commercial reality. The idea of virtualizing, not just hardware, but software resources as well, has attracted the attention of academicians, as well as the industry. Cloud computing not only offers a viable solution to the problem of addressing scalability and availability concerns for large-scale applications but also displays the promise of sharing resources to reduce cost ownership. The concept has evolved over the years starting from data centers to present day infrastructure virtualization. Technically, cloud computing is still to mature and there are still many challenges, including fundamental models, infrastructure and architectures provision of services, and development of applications. This work provides a comprehensive tutorial on cloud testing and cloud-based application testing. It provides clear concepts, discusses the special objectives, features, requirements, and needs in cloud testing.*

***Key words**: cloud computing; software testing; cloud testing; cloud-based software testing; testing cloud services.*

I. Introduction

The actual term "cloud" borrows from telephony in that telecommunications companies, who until the 1990s offered primarily dedicated point-to-point data circuits, began offering Virtual Private Network (VPN) services with comparable quality of service but at a much lower cost. Cloud computing is a natural evaluation of the wide spread adoption of virtualization [1], service-oriented architecture, autonomic and utility computing. Details are abstracted from end-users, who no longer have need for expertise in, or control over, the technology infrastructure "in the cloud" that support them.

Cloud computing is not a new:

- Technology that one should learn to be side by side for future business
- Architecture that would help in easier software deployment
- Standard or protocol

In fact, one of the main issues that technical leaders are trying to address is interoperability between Cloud platforms. The introduction in any white paper or article or blog discussing Cloud computing often states, 'Cloud computing is not new. It has been there since the inception of formal business contracts [1]'. The following is definition of Cloud computing coming from a beginner that should clear the air for all novices starting with the usage 'As a Service': 'Cloud computing is a business and economic model. This model has been successfully deployed and executed for various material commodities since its inception, but in the recent years it has been formalized for IT products and services'.

Take the analogy of automobiles to understand the use case of Cloud computing. Take the case of a car versus a taxi cab. Both are automobiles with the basic functionality of transferring people goods from one place to other [2]. The difference is in the business model for the service provided by them. As the owner of a car, to pay for the petrol or diesel, maintenance and possibly a garage. The car provides the service solely to the owner. On the other hand, the service provided by the taxi cab can be described as 'Travel as a service'. The taxi cab driver owns the cab. As a customer, pay to travel whenever using the cab service. There is no need to pay for the maintenance or the gas and don't need to worry about the parking. This responsibility lies with the cab driver. This is why Cloud is synonymous with 'On Demand'. Pay only on demand.

Specifically in the IT industry, there is a wide range of products and services available on demand. Almost every day, notice various 'as a service' offerings like 'Games as a service', 'Java as a service', 'Storage as a service' and the list is endless.

Testing is a periodic activity and requires new environments to be set up for each project. Test labs in companies typically sit idle for longer periods, consuming capital, power and space. Approximately 50% to 70% of the technology infrastructure earmarked for testing is underutilized, according to both anecdotal and published reports [3].

Testing is considered an important but non-business-critical activity. Moving testing to the cloud is seen as a safe bet because it doesn't include sensitive corporate data and, has minimal impact on the organization's business-as-usual activities.

Applications are increasingly becoming dynamic, complex, distributed and component-based, creating a multiplicity of new challenges for testing teams. For instance, mobile and Web applications must be tested for multiple operating systems and updates [4], multiple browser platforms and versions, different types of hardware and a large number of concurrent users to understand their performance in real-time. The conventional approach of manually creating in-house testing environments that fully

mirror these complexities and multiplicities consumes huge capital and resources.
The cost savings in implementing a cloud system is substantial [5] [6], and the pricing for use of cloud computing can easily be scaled up or down as determined by necessity.

II. Introduction to cloud computing

An environment creates in a user's machine from an on-line application stored on the cloud and run through a web browser [7]. In simple cloud computing is using the internet to access someone else's software running on someone else's hardware in someone else's data center [8] [9]. Distributed computing on internet or delivery of computing service over the internet. Eg: Yahoo, Gmail and Hotmail [10].
Internet-based computing in which large groups of remote servers are networked so as to allow sharing(of data processing tasks, centralized data storage, and online access to computer services or resources Cloud computing is internet based computing where virtual shared severs provide software, infrastructure, platform, devices and other resources and hosting to customers on a pay-as-you-use basis. All information that a digitized system has an offer is provided as a service in the cloud computing model. Users can access these services available on the "internet cloud" without having any knowledge on managing the resources [11]. Thus, users can concentrate on their core business processes instead of spending time and gaining knowledge on resources needed to manage their business processes. Cloud computing customers don't need to have the physical infrastructure as own and they rent the usage from a third-party cloud provider and it may save more money. They consume resources as a service and pay based on their usage. Most cloud computing infrastructures consist of services delivered through common centers and build on servers. Sharing resources can improve, as servers are not unnecessarily kept idle, which can reduce cost significantly while increasing the speed of application development.
Cloud Computing is a technology that uses the internet and central remote servers to maintain data and applications. Cloud computing allows consumers and businesses to use applications without installation and access their personal files at any computer with internet access. This technology allows for much more efficient computing by centralizing data storage, processing and bandwidth [12]. The need is just an internet connection and can start sending emails. The server and email management software is all on the cloud (internet) and is totally managed by the cloud service provider Yahoo, Google etc. The consumer gets to use the software alone and enjoy the benefits.

a. A Small Comparison among Distributed, grid and cloud

Levels	Distributed	Grid	Cloud
Time	Weeks to month	Days to week	Minutes
Scalability	Slowest, rigid and costly	slower somewhat flexible, costly	Instant, flexible pay per use
Cost	High capital expenses	Costly sometimes flexibility, costly	No contracts usage based, no upfront costs
Green	Low	Low	High virtualized
Primary model	Buy servers for high cost whether used or not	Rent servers and hosting costs whether used or not	Rend based on usage only

b. Infrastructure as a Service (IaaS):

As with all cloud computing services it provides access to computing resource in a virtualized environment, "the Cloud", across a public connection, usually the internet. In the case of Infrastructure as a Service (IaaS) the computing resource provided is specifically that of virtualized hardware, in other words, computing infrastructure. The definition includes such offerings as virtual server space, network connections, bandwidth, IP addresses and load balancers [13]. Physically, the pool of hardware resource is pulled from a multitude of servers and networks usually distributed across numerous data centers, all of which the cloud provider is responsible for maintaining. The client, on the other hand, is given access to the virtualized components in order to build their own IT platforms. In common with the other two forms of cloud hosting, IaaS can be utilized by enterprise customers to create cost effective and easily scalable IT solutions where the complexities and expenses of managing the underlying hardware are outsourced to the cloud provider. If the scale of a business customer's operations fluctuate, or they are looking to expand, they can tap into the cloud resource as and when they need it rather than purchase, install and integrate hardware themselves.
A typical Infrastructure as a Service offering can deliver the following features and benefits:
Scalability: Resource is available as and when the client needs it and, therefore, there are no delays in expanding capacity or the wastage of unused capacity.
No investment in hardware: The underlying physical hardware that supports an IaaS service is set up and maintained by the cloud provider, saving the time and cost of doing so on the client side.

Utility style costing: The service can be accessed on demand and the client only pays for the resource that they actually use.

Location independence: The service can usually be accessed from any location as long as there is an internet connection and the security protocol of the cloud allows it.

Physical security of data centre locations: Services available through a public cloud, or private clouds hosted externally with the cloud provider, benefit from the physical security afforded to the servers which are hosted within a data centre

No single point of failure: If one server or network switch, for example, were to fail, the broader service would be unaffected due to the remaining multitude of hardware resources and redundancy configurations. For many services if one entire data center were to go offline, never mind one server, the IaaS service could still run successfully.

c. Platform as a Service (PaaS)

It provides a platform and environment to allow developers to build applications and services over the internet. PaaS services are hosted in the cloud and accessed by users simply via their web browser. It allows users to create software applications using tools supplied by the provider. PaaS services can consist of preconfigured features that customers can subscribe to; they can choose to include the features that meet their requirements while discarding those that do not.

Consequently, packages can vary from offering simple point-and-click frameworks where no client side hosting expertise is required to supplying the infrastructure options for advanced development. The infrastructure and applications are managed for customers and support is available. Services are constantly updated, with existing features upgraded and additional features added. PaaS providers can assist developers from the conception of their original ideas to the creation of applications, and through to testing and deployment [13]. This is all achieved in a managed mechanism. As with most cloud offerings, PaaS services are generally paid for on a subscription basis with clients ultimately paying just for what they use. Clients also benefit from the economies of scale that arise from the sharing of the underlying physical infrastructure between users, and that results in lower costs.

The following are some of the features that can be included with a PaaS offering:

- Operating system
- Server-side scripting environment
- Database management system
- Server Software
- Support
- Storage
- Network access
- Tools for design and development
- Hosting

Software developers, web developers and businesses can benefit from PaaS. Whether building an application which they are planning to offer over the internet or software to be sold out of the box, software developers may take advantage of a PaaS solution. For example, web developers can use individual PaaS environments at every stage of the process to develop, test and ultimately host their websites. However, businesses that are developing their own internal software can also utilize Platform as a Service, particularly to create distinct ring-fenced development and testing environments.

Some of the benefits of PaaS to application developers are as follows:

No investment in physical infrastructure: Being able to 'rent' virtual infrastructure has both cost benefits and practical benefits. They don't need to purchase hardware themselves or employ the expertise to manage it. This leaves them free to focus on the development of applications. What's more, clients will only need to rent the resources they need rather than invest in fixed, unused and therefore wasted capacity.

Makes development possible for 'non-experts': With some PaaS offerings anyone can develop an application. They can simply do this through their web browser utilizing one-click functionality. Salient examples of this are one-click blog software installs such as Word Press.

Flexibility: Customers can have control over the tools that are installed within their platforms and can create a platform that suits their specific requirements. They can 'pick and choose' the features they feel are necessary.

Adaptability: Features can be changed if circumstances dictate that they should.

Teams in various locations can work together: As an internet connection and web browser are all that is required, developers spread across several locations can work together on the same application build.

Security: Security is provided, including data security and backup and recovery.

In summary, a PaaS offering supplies an operating environment for developing applications. In other words, it provides the architecture as well as the overall infrastructure to support application development. This includes networking, storage and software support and management services.

d. Software As A Service (SAAS)

The applications are hosted in "the cloud" and can be used for a wide range of tasks for both individuals and organizations [14]. Google, Twitter, Facebook and Flicker are all examples of SaaS, with users able to access the services via any internet enabled device. Enterprise users are able to use applications for a range of needs, including accounting and invoicing, tracking sales, planning, performance monitoring and communications (including webmail and instant messaging).

SaaS is often referred to as software-on-demand and utilizing it is akin to renting software rather than buying it. With traditional software applications would be purchased the software upfront as a package and then install it onto the computer. The software's license may also limit the number of users and/or devices where the software can be deployed. Software as a Service users, however, subscribe to the software rather than purchase it, usually on a monthly basis. Applications are purchased and used online with files saved in the cloud rather than on individual computers.

There are many reasons why SaaS is beneficial to organizations and personal users alike:

No additional hardware costs: The processing power required to run the applications is supplied by the cloud provider.

No initial setup costs: Applications are ready to use once the user subscribes.

Pay for what you use: If a piece of software is only needed for a limited period then it is only paid for over that period and subscriptions can usually be halted at any time.

Usage is scalable: If a user decides they need more storage or additional services, for example, then they can access these on demand without needing to install new software or hardware.

Updates are automated: whenever there is an update it is available online to existing customers, often free of charge. No new software will be required as it often is with other types of applications and the updates will usually be deployed automatically by the cloud provider.

Cross device compatibility: SaaS applications can be accessed via any internet enabled device, which makes it ideal for those who use a number of different devices, such as internet enabled phones and tablets, and those who don't always use the same computer.

Accessible from any location: Rather than being restricted to installations on individual computers, an application can be accessed from anywhere with an internet enabled device.

Applications can be customized and white labeled: with some software, customization is available meaning it can be altered to suit the needs and branding of a particular customer.

Office software is the best example of businesses utilizing SaaS. Tasks related to accounting, invoicing, sales and planning can all be performed through Software as a Service. Businesses may wish to use one piece of software that performs all of these tasks or several that each perform different tasks. The required software can be subscribed to via the internet and then accessed online via any computer in the office using a username and password. If needs change they can easily switch to software that better meets their requirements. Everyone who needs access to a particular piece of software can be set up as a user, whether it is one or two people or every employee in a corporation that employs hundreds.

e. Cloud Computing Architecture

When talking about a cloud computing system, it's helpful to divide it into two sections: the front end and the back end. They connect to each other through a network, usually the Internet. The front end includes the client's computer (or computer network) and the application required to access the cloud computing system [14]. Not all cloud computing systems have the same user interface. Services like Web-based e-mail programs leverage existing Web browsers like Internet Explorer or Firefox [15]. Other systems have unique applications that provide network access to clients.

On the back end of the system are the various computers, servers and data storage systems that create the "cloud" of computing services. In theory, a cloud computing system could include practically any computer program, from data processing to video games. Usually, each application will have its own dedicated server.

A central server administers the system, monitoring traffic and client demands to ensure everything runs smoothly. It follows a set of rules called protocols and uses a special kind of software called middleware. Middleware allows networked computers to communicate with each other. Most of the time, servers don't run at full capacity. That means there's unused processing power going to waste. It's possible to fool a physical server into thinking it's actually multiple servers, each running with its own independent operating system. The technique is called server virtualization. By maximizing the output of individual servers, server virtualization reduces the need for more physical machines.

If a cloud computing company has a lot of clients, there's likely to be a high demand for a lot of storage space. Some companies require hundreds of digital storage devices. Cloud computing systems need at least twice the number of storage devices it requires to keep all its clients' information stored. That's because these devices, like all computers, occasionally break down [14]. A cloud computing system must make a copy of all its clients' information and store it on other devices. The copies enable the central server to access backup machines to retrieve data that otherwise would be unreachable. Making copies of data as a backup is called redundancy.

f. Cloud computing Deployment

Cloud computing can be deployed using a number of different models.

Private cloud: The cloud customer is the sole user of the cloud service. The underlying hardware may be managed and maintained by a cloud provider under an outsourcing contract. Access to the cloud service may be restricted to a local or wide area network.

Community cloud: A group of cloud customers access the resources of the same cloud service. Typically the cloud customers will share specific requirements such as a need for legal compliance or high security which the cloud service provides. Access to the cloud service may be restricted to a wide area network.

Public cloud: The infrastructure, platform or software is managed by the cloud provider and made available to the general public (cloud customers or cloud end-users). Access to the cloud service is likely to be over the public internet.

Hybrid cloud: Describes a combination of private, community and public clouds. A cloud customer will segregate data and services across different cloud services, with access between them restricted depending on the type of data they contain.

III. Different Types of Testing in Cloud Computing

Consider the various types of testing that should be carried out.

Availability Testing: Cloud offerings must be available at all the times. It is the responsibility of the Cloud vendor to ensure that there are no abrupt downtimes. In addition the business of the client must not be adversely affected in case of any planned down time [14]

Security Testing: There must be no unauthorized access to data. Shared data integrity should be maintained and secured at all times. At present several organizations and communities are formalizing industry standards to define the acceptability criteria for Cloud offering in terms of security Any on-premise application is as much prone to unauthorized access as any Cloud offering.

Performance Testing: Performance measurement for a Cloud offering is different from on-premise offering. The Cloud should be elastic. Elasticity enables enterprises to use limited resources from the Cloud application and increase the usage as required. Hence, the Cloud offering should be tested for fluctuating usage. The performance of the application should stay intact with maximum inflow of requests. Testing should also ensure that automatic de provisioning occurs as the load decreases. To test the offering in case of increasing load and stress, two of the following traditional performance testing methods are used:

- Load testing
- Stress testing

Interoperability Testing: Any developed or migrated Cloud application must work in multiple environments and platforms. The application should also have the capability to be executed across various Cloud platforms. It should be easier to move the Cloud applications and platforms from one Infrastructure (as a service) to another Infrastructure. As with Security Testing, standards are being formalized for interoperability between diverse Cloud offerings too. Cloud Computing is an excellent business model if the security and flexibility concerns are addressed [14].

Disaster Recovery Testing: It is preferred that a Cloud offering be available all the time, though it is not 100% achievable even for on-premise applications. In case of a failure, the disaster recovery time must be low. Verification must be done to ensure the service is back online with minimum adverse effects on the client's business

Multi-tenancy Testing: Multi-tenancy refers to multiple clients and organizations using an on demand offering. Considering the requirements to be verified for multi-tenancy, the offering should be customizable for each client and should provide data and configuration level security to avoid any access related issues. A Cloud offering should be thoroughly validated for each client whenever multiple clients are active at a given time. To decide on verification and validation strategies, Cloud vendors must understand the technical and commercial aspects of their Cloud offering. Migration of an on-premise application to the Cloud requires a comprehensive test plan and execution at every stage of migration.

IV. Testing Tools

Few of the most commonly used tools for Cloud Testing are summarized below [16] and [17]:

Performance Monitoring tools such as: [16]

- Perfecto Mobile's
- Keynote
- Monitis
- Cloudsleuth
- BrowserMob
- CloudTools
- GFI
- LoadStorm
- CloudHarmony
- InterMapper
- BlazeMeter

Web Functional/Regression Test Tools [16]

- Windmill
- QEngine
- Soasta
- Selenium

Large Scale Performance & Scalability Testing [17]

- ETHZ [18]
- YCSB [19]
- Benchmark [20]

Fault Tolerance and Recovery Testing [17]

- D-Cloud [21]
- Pre-Fail [22]

V. Cloud Testing Challenges

There are some challenges with relying and using cloud as an infrastructure as well. Let's take a look at some of the primary concerns using the cloud.

With everything available on demand to any user, security is a primary issue for the businesses as currently there is still a lot of discussion and research going on in the industry to set up security standards. User privacy protection, security standards on cloud, security of applications running within the cloud, security testing techniques are some of the primary issues that need to be addressed in the cloud infrastructure.

Another big challenge is the performance of an application in a cloud: specifically in private clouds. It will be shared across many users and hence could lead to delays. Also in case of some maintenance or outage related activities, the bandwidth may seem insufficient.

Sometimes for testing purposes, we require certain configurations: with respect to servers, storage or networking which may not be supported by the cloud provider. This sometimes makes it difficult to emulate customer environments.

Another commonly faced challenge is with respect to integration testing whereby the testers test the network, database, servers, etc. In such situations the tester will not have control on the underlying environment. Secondly, the challenge is doubled when there has to be an interaction between these components because the tester will have to anticipate risks like crashes, network breakdown or servers going kaput.

VI. CONCLUSION

Cloud Applications for business are still in their growing stages. Cloud testing is a rapidly emerging area in cloud computing. While cloud testing is still maturing, some interesting theoretical and practical results have been achieved. Only less advantages and less testing challenges of cloud computing had been identified. Testing is a periodic movement and new requirements need to be setting up for future trends. The future is going to be cloud computing solutions for large as well as small and medium business environments.

Reference:

1. www.infosys.com/cloud-testing-vs-testing-cloud.pdf.
2. www.cognizant.com/SiteDocuments/ITIS-Cloud-Based-Testing.pdf.
3. ibm.com/in/cloud computing.
4. www.zdnet.com/article/australian-clouds-compared.
5. www.slideshare.net/dattudharanikota/cloud-operating-systems
6. en.wikipedia.org/wiki/Cloud computing.
7. www.netsolutionsindia.com/blog/what-is-cloud computing.
8. A Joshua, F Ogwueleka - International Journal of Cloud Computing 2012 - iaesjournal.com.
9. N Khanghahi, R Ravanmehr - computing, 2013 - airccse.org
10. M Zhou, R Zhang, W Xie, Grid (SKG), 2010 Sixth 2010 - ieeexplore.ieee.org.
11. P Gavhane, P Kurumkar, M Jagtap, D Mahajan - 2013 - ijcsmc.com
12. MA Singh, DM Shrivastava - Journal of Advanced Computer 2012 - accentsjournals.org.
13. BP Rimal, E Choi, I Lumb - INC, IMS and IDC, 2009. NCM'09. 2009 - ieeexplore.ieee.org
14. N.Mehrotra - 10th Annual International Software Testing Conference, 2011 - infosys.com.
15. Q Zhang, L Cheng, R Boutaba of internet services and applications, 2010 - Springer.
16. Belatrix Software Factory, "Cloud Testing Best Practices".
17. X. Bai, M. Li, B. Chen, W. T. Tsai, and J. Gao, "Cloud Testing Tools," IEEE 6th International Symposium on Service Oriented System Engineering (SOSE), 2011 .
18. J. Moreno, "A Testing Framework for Cloud Storage Systems", Diss. Master Thesis, Eidgenössische Technische Hochschule, Zürich, 2010.
19. B. Cooper, A. Silberstein, E. Tam, R. Ramakrishnan, and R. Sears, "Bench Cloud Serving Systems with YCSB," 1st ACM Symposium on Cloud Computing, pp. 143–154, 2010.
20. C. Binnig, D. Kossmann, T. Kraska, and S. Loesing, "How is the Weather Tomorrow? Towards a Benchmark for the Cloud," Second International Workshop on Testing Database Systems, pp. 9:1 - 9:6, 2009.
21. T. Banzai, H. Koizumi, R. Kanbayashi, T. Imada, T. Hanawa, and M. Sato, "D-Cloud: Design of a Software Testing Environment for Reliable Distributed Systems using Cloud Computing Technology," 10th IEEE/ACM International Conference on Cluster, Cloud and Grid Computing, pp. 631–636, 2010.
22. P. Joshi, H. S. Gunawi, and K. Sen, "PreFail: a Programmable Tool for Multiple-Failure Injection," ACM International Conference on Object oriented Programming Systems Languages and Applications," pp. 171–188, 2011.