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Research Paper

Cloud Based Performance Testing

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ABSTRACT: *Cloud-based performance testing is a stem of cloud-based testing and it is viewed as one of the cloud-based testing models among others.Since the performance measurement that is done is relative to the cloud, it is a requirement to model the test suites that un-doubtedly and totally imitates the real life scenarios. Cloud-based testing closes the gap in the hardships of creating the test cases that can number up to several thousands, which is very expensive and needs vast amount of time.In this paper we give a short literature of the proposed and implemented cloud-based performance testing frameworks, made an analysis of the presently found cloud-based testing models against cloud-based providers,our recommended parameters that are required to be taken into considerationwhilst performing cloud-based performance testing along with their expected practical results.*

Keywords:*Cloud computing, Cloud based testing, Cloud-based performance testing, Test Coverage*

I. INTRODUCTION

A cloud in its simplest definition is just a data center hardware and software. In describing this technology, cloud computing is the use of computing resources (hardware and software) that are delivered as a service over a network (typically the Internet),moreover it can be provided at an on-demand access and configured for specific needs[1]. The name comes from the use of a cloud-shaped symbol as an abstraction for the complex infrastructure it contains in system diagrams. Cloud computing entrusts remote services with a user's data, software and computation.

This paper is structured in way such that; section2 outlines the research methodology, followed by section3 that is composed of the discussion of the merged concepts of software testing and cloud computing. Section 4 describes cloud based testing and take us through to the concepts of cloud based performance testing. Sections 5 provides a cost and benefit analysis of conventional software testing and cloud based testing and finally section 6 brings us to the conclusion and future work.

II. RESEARCH METHODOLOGY

From the whole pool of the available models, focus has been given on cloud-based performance testing. For us to obtain a broad point of view, we explored widely in electronic sources since this editorialanticipates at presenting a comprehensive, loaded, summative and well summarisedstudy on cloud based performance testing.

III. DISCUSSION OF THE MERGED CONCEPTS

Here we introduce two merged concepts that are concatenated to bring about the existence of cloud-based performance testing. These encompass the brief understanding of software testing and cloud based testing in general, although this automatically borrows from cloud computing technology.

3.1. Briefing on software testing

It is the assessment process of the functional and non-functional characteristics of a program, through the execution process of that particular program. In this execution process the main goal is to findfaults.

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Ultimately after testing, value must be added to the program, which means raising the quality and/or reliability of the program. Effective software testing contributes to the delivery of high quality software products, lower maintenance costs, more satisfied users, more accurate and reliable results. Thus software testing has mainly contributions: to make a judgement about quality or acceptability of the product and to discover problems, if there are any, in the product.

Designing test cases is the most demanding task in software testing. Execution of the test cases does not require much time, skill and resources. Traditionally designing and execution of test cases is manually done.

However with the advent of cloud computing, there is need to have software testing tools that necessitate software testers to embark on the testing task and finish this within the shortest possible time with a beneficial advantage of easiness as well. The main drive of this notion is to come up with the automated testing that can be carried with little or no human involvement. Conclusively it is of no doubt that this will in turn be beneficial in cases where the same dataset (mainly as input) will be repeatedly used time and again.

3.2. A moveto cloud-based testing

Software testing has been and till date is still being moved to the cloud environment. Part of the technology of cloud computing known as virtualization is the back bone for this, as it allows the rapid establishment of virtual computing resources with different operating systems to test software applications on a range of platforms. Although it depends on different application domains, in some, software testing requires widespread resources. Repeating realistic scenario/s would require the provider to lay down a test harness (that includes user databases) to emulate the activities of a millions of users.Test automation tools that address different requirements in a testing life-cycle are of great importance, for instanceautomated test data and test case generations, test execution and test evaluation.

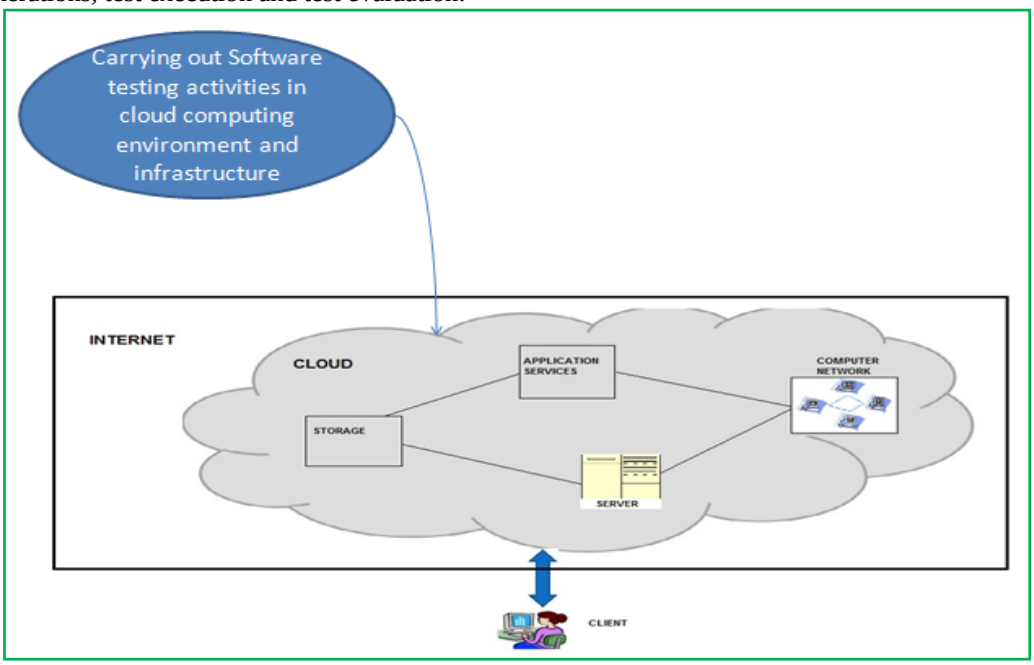

Figure 1: Visualizing the concept of cloud based testing

IV. CLOUD-BASED TESTING

Cloud computing did not bring only novel business opportunities, all the same it also has various major impacts in the software testing domain, along with even software maintenance. Since cloud computing is characterised by offering its accessible resources as services, hence this brings us to the notion of Testing as a Service (TaaS) on and/or in clouds. TaaS is considered as a service model, in which a Cloud Service Provider (CSP) takes on software testing activities of a given application system in a cloud computing environmenton behalf of its clients as a service as per their requests and/or demands. Taking on this discussion up to this end brings us to the proper definition of Cloud-Based Software Testing (CBST). Cloud-Based Software Testing means carrying out testing activities in a cloud computing environment and infrastructure as visualised in figure 1. In a different way of expression, CBSTis a means of using the cloud to support the software testing discipline, but indeed it requires care. It brings the opportunity to test by harnessingthe cloud**,** in so doingbringing the alikeenjoyable benefits that the cloud ascertains to customers**.** Hence its greatest advantage is that it exploits the already existing cloud computing resources, in so doing inheriting some of the same benefits that cloud computing already has.

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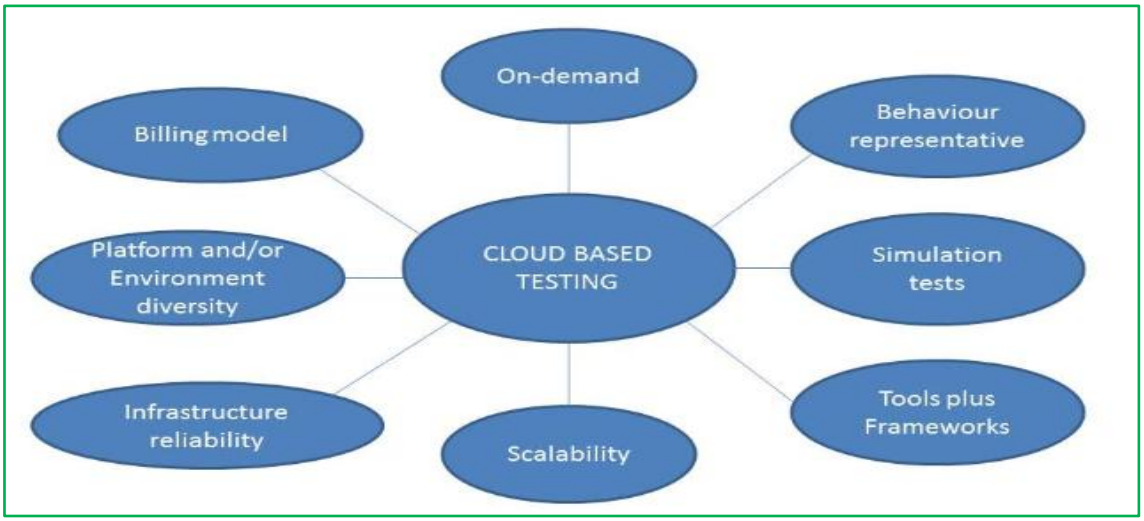

Figure 2:Distinct features of Cloud-Based Testing

- On-demand: Cloud based testing facility is accessible whenever it is needed by clients
- Behaviour representative: Cloud based testing facility must imitate real world scenarios during the testing process so as to output dependable results.
- Simulation tests:These help in reducingthe complexity as well as separatingthe quality concerns, plus it can focus on and analyses system behaviour under multiple various scenarios.
- Tools plus Frameworks:Various tools and frameworks do exist at various layers and in different forms to enhance cloud-based testing, and tools aids in automation.
- Scalability: Cloud based testing facility must be able to handle a number of requests, as rooted by clients, and must be able to either scale up or down depending on a number of requests at a particular point in time.
- Infrastructure reliability: Cloud based testing facility must be in such a way that it has high level of availability to satisfy 24/7 continuous manner of testing.
- Platform and/or Environment diversity: Cloud based testing facility must provide diversity of environment (e.g. network and hardware) along with computing platform (e.g. Operating system and browser) to handle different requests from different clients using different platforms.
- Billing model: Cloud based testing facility is charged as per the predefined cost models, and in the form of pay as per use mode.

A several number of testing models do exist in Cloud based testing as proposed by different researchers in the literature that has been used. Hence an analysis has been made, against each cloud based service provider and the models that it supports as at the present date, combined from different sourcesas tabled in 1:

Table 1: Analytical Analysis

CLOUD-BASED TESTING PROVIDER	**CLOUD BASED TESTING MODELS**					
	Performance Testing[2][3]	**Privacy Aware Testing[4][5]**	**Fault Injection Testing[6]**	**Model based Testing [7][8][9][10][11]**	**Random Testing[12]**	**Symbolic Execution[13][14]**
Soasta	✓	✓	✓	✓	✓	✓
STaaS	**X**	✓	**X**	✓	**X**	**X**
Sauce Labs	✓	✓	**X**	**X**	✓	**X**
Skytap	✓	✓	✓	**X**	✓	**X**
UTest	✓	✓	**X**	**X**	✓	**X**
PushToTest	✓	✓	**X**	**X**	**X**	**X**
BlazeMeter	✓	✓	**X**	✓	✓	**X**
IBM	✓	✓	✓	✓	✓	✓

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4.1. Centred onCloud-Based Performance Testing (CBPT)

Cloud based testing is a remedy to the less than practical performance testing that is brought about by clients as per their testing requests. This is made possible because of the already existinghardware as well as bandwidth that nearlyimitatereal world conditions, i.e. consumertrafficby ways of loadand/or stress testingtoweb sites.It enables manual creation and maintenance of test scripts or to make use of the record and replay scheme. Testing services that it offers necessitate whoever is performing the test, be it developers, testers or managers to automate along with speeding up the testing as well as archiving using real life scenarios from the cloud.

Various tools are available to test cloud-based systems at various layers including hardware interface, platform interface, storage system, and application systems. Commercial testing tools such *SOAST* and*iTKO LISA* are also now available [15].

Sebastian Gaisbauer et al. [16] implemented VATS for an automatic performance evaluator for Cloud environments. VATS uses HP LoadRunner as a load generator as well asto provide the foundation for an automatic performance evaluator for Cloud environments.

Marco A. S. Netto et al. [17] uses a virtualized settingdesigned for load generation intended at performance testing.

In [18] there is a proposed design for a cloud-based performance testing system for web services. In their paper, performance testing is a notable vital activity spanning the whole life cycle of software engineering. They presented the cloud-based performance testing system for web services, which is a portable, extensible, and easy-to-use framework for generating and submitting test workloads to computing clouds. It adopts cloud computing technique to build elastic resource infrastructures and provides various kinds of testing services to users, such as multi-user concurrency testing, dynamic migration, automatically generating and executing test cases, collecting test results and reporting to testers.

In [19] proposed is an AGARIC (A Hybrid Cloud based Testing Platform) that is simulated with more focus on the way to test the online web applicationsin variedand scalable ways. It brings the notion that there are several service models designed: Software as a service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS); giving that the resources in the three models are used and organized in a centred cloud in which distributed server clusters are deployed by the same provider usually. In addition to the three ones, another proposal is Human as a Service (HaaS) in which a crowd of people can use the cloud technology from different geographical places and work together to complete a task. HaaS brings diversity of resources into cloud thus can better serve its customers. The hybrid cloud based testing (as a mixture of HaaS and SaaS) was proposed to make use of the diverse distributed user and centred cloud computing resources to provide online testing services.

However in a number of proposed designs no parameters (that have to be considered in practical implementation) are clearly defined with easiness.This is an important aspect since online testing of cloud based applications requires particular concerns on load and user experiences. The load of such application might change sharply from hundreds of parallel accesses to a scale of millions. Therefore, different users usually have different quality and user experiences. Therefore, the online performance testing needs to make a consideration about a range of devices with different hardware configurations, software configurations and network situations hence our need to pinpoint on the recommended parameterized list.

4.2.Recommended CBPT Modelled ParameterList as per web services

The more accurate the load profile can be made, the closer the performance tests will model the real world conditions that the user base (clients/consumers) will ultimately have to survive. This, in turn, will lead to more reliable test results. Elements that are capable of affecting web load are addressed. Load parameters that should be taken into considerationwhile creating the test load that have to be used for cloud based performance testing are listed as follows:

4.2.1. Client/ Consumer Activities: Transactions that take place more often than others ought to comprise a biggerratio of the test data as well as scripts used for cloud based performance testing. The test data and scripts must be a realistic representation of the types of transactions that acloud computing data center isanticipated to handle.

4.2.2. Think Times: The amount of time taken by a client to act in response to a cloud computing center can give predictable number of clients that a givencenter can support.The difference between times at which a client receives the last data response from a data center for the service that is currently being used to the time that the client requests the next new service is the one that's considered as think time.Randomizing algorithm can be created to model these actions.

4.2.3. Client Internet Access Speeds/Bandwidth: The transmission speed that is commonly referred to as bandwidth that thecloud-based application uses can have a noteworthy impact on the overall performance testing of cloud.

4.2.4. Background Noise: This check on the appropriate background tasks for servers and network in the system test environment. Background noise causes performance deterioration. The produced noise by other applications will run behind on the production servers when the application under test moves into production, and other network traffic that will guzzle network bandwidth and probably increase the collision rate of the data packets being transmitted over the LAN and/or WAN.

4.2.5. Client Platforms: Various client-side products likeoperating systems and web browsers will cause small different HTTP traffic that can be sent to the internet during the cloud performance testing.

4.2.6. User Geographic Locations: This is the geographic detachment in terms of distance between the client (customer/consumer) and the host data center, and this brings the issue of network capabilitiesto be considered. Remote performance testing can turn out to bepredominantlyessential if mirror sites are to be tacticallylocatedso as toenhance response times for far-off locations.

The summed up effects of a number of parameters may have a considerable impact on the test results, although individually the parameters may only have an effect on the test results by a few percentage.Cloud-based performance testing must be in such a way that it enables the modeller to execute tests repeatedly with changes to the parameters easily and quickly.Since the accessibility of the cloud computing resources is through the internet, introduction of concepts that model internet and internet application behaviour(s) must be put in place. The Cloud based performance testing models the internet traffic routing around the globe by introducing suitable transmission latency and data transfer delays. The transmission latency and the available bandwidth must be well represented, with the help of certain algorithms (most common in simulations) that are used as well as in performing these tests, these includes:

1) Round-robin Load Balancer-uses aneasy round-robin algorithm in its allocation of(Virtual Machines) VMs
2) Active Monitoring Load Balancer-This version balances the load among all available VM's in a way to even the number of active tasks on each VM at any given time.
3) Throttled Load Balancer-This makes sure that only a pre-defined number of Internet Cloudlets are directed to a single VM at any given single point in time. If more request groups are present than the number of available VM's at a data center, some of the requests will be in a pending status until the next VM becomes available.

4.3. PracticalCBPTresults

Cloud based performance testing test results must give out the results of at leastthe following:

4.3.1. Response time of an application: Overall average, minimum and maximum response time of all requests tested.

4.3.2. The usage patterns of the application: How many users use the application at what time from different regions of the world, and the overall effect of that usage on the cloud computing center hosting the application.

4.3.3. The time taken by data centers to service a user request: The average, minimum as well as maximum request processing time by each and every data center. The response time variations pattern during the day as the load changes.

4.3.4.The cost of operation: The cost of use is part of the output since there is accessed as pay-per use criteria that like just as in cloud computing in general.

V. COST AND BENEFIT ANALYSIS OF CONVENTIONAL SOFTWARE TESTING AND CLOUD BASED TESTING

Conventional Software Testing	Cloud Based Software Testing
Testing setup time is generally minutes or days or weeks or more	Cuts down its testing setup time from weeks to minutes
It is not that of a large-scale as in Cloud based software testing.	Enables large-scale and valuable real-time online testing for internet-based software in clouds.
Mostly, kind of lab testing	Easily leverage scalable cloud computing infrastructure to test and evaluate system (SaaS) performance and scalability.
Costs are higher in the long run, but may seem to be cheaper when cloud based software testing is still in its initial set up phases	Reduced costs since it utilises the same computing resources in cloud(s) for its testing purposes.
Not that flexible	More flexibility enhanced collaboration
No cases of data security challenges	Data security challenges
No standards challenges	Challenge of lack of standards

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5.1. Key benefits of Cloud Based Testing

Cost reduction is of course the main advantage of moving to cloud based testing. However it's important to note that cloud-based testing also offers extra significant benefits[20][21][22][23][24]. All three levels of testing are supported by cloud based testing environments, and indeed, various types of testing immensely benefit from a test environment.

5.1.1.Flexibility: Separate environments can be used to run different levels of tests, as per an organizations' convenience. There won't be any need to long wait until the last part of the testing phase hence production-like environment can be put into action at will.

5.1.2. Simplicity: Setting up of end-to-end testing in the cloud can be relatively simple, given that the required servers and images are available for use in the creation of end-to-end environment, again configuration can be set with easiness too.

5.1.3. Comprehensive and indicative testing: Cloud based testing can even be carried out for end-to-end tests of generic business processes. All the required components are published into the cloud environment thereby creating the entire chain of systems. If this is done, then the complete business processes will be tested. More so cloud based testing allows a more realistic load to be generated; this result in test results to be more accurate, especially in cases of load and stress tests.

5.1.4. Cleaner, Greener Testing: It is naturally true that cloud computing gives efficiencies that are significantly greener than traditional models, the same applies for cloud based testing too, in comparison to conventional software testing.

5.1.5.Geographic Transparency and Traceability: Test data is at times highly sensitive thus its location is important, since data passing through national borders can be in breach of nationwide and international regulations, so the cloud-based test is transparent in relation to the geographic position where data along with services are stored and let customers to store data at their servers, using VPN connection.

5.1.6.Driving Standardization: Creating test environments for cloud-based software testing are simply a first step of a long journey. Cloud computing will offer a huge momentum in terms of the organizations' infrastructure standardization. This crucial move will certainly catalyse IT modernization as well as improving organizations' IT services maturity.

5.1.7. Support for complex apps: Applications are more and more becoming complex, component-based, dynamicand distributed. Then conventional software testing environments are proving to be gradually more expensive at thesame time becoming ineffective when handling such complexities, hence cloud based testing is the solution to go for.

5.1.8.Improved test quality: Cloud-based testing mechanisms puts in place a standardized pre-configured software images and infrastructure that are capable of eradicating inaccurate configuration of software test environments hence unwanted errors.

5.1.9. Time-to-market: Normally it is time consuming to create on-premise test environments, and this might cause project delays. However with cloud-based testing, this won't be the scenario since there will be standardised testing environments which can be used time and again, depending on type of applications.

5.1.10. Real-time testing: Cloud-based testing environments permit testers to make an analysis of application performance, identifying bottlenecks even when tests are running.

5.1.11.Scalability: Cloud-based testing allows testers to quickly scale multiple simultaneous users so as to make an assessment of applications' breaking points as well as determining capacity thresholds in cases of highly unpredictable demand.

5.1.12. Testingefficiency will be improved: Using cloud based testing; the time to set up a test environment can be greatly reduced.

5.1.13. There is more realistic performance testing: On the cloud based testing platform, performance test and other different tests are of a more realistic scenario.

5.1.14. Changes in the external environment: The advancement of cloud computing technology means cloud based testing also progresses hence enjoying the benefits of any progress in cloud computing technology.

5.2. Challenges of Cloud-Based Testing

Besides its goodness, cloud-based testing also has limitations too [20][21][24]. Organizations must be competing with a set of challenges in their desire to reap cloud- based testing's benefits. Cloud-based testing needs testing of supplementary aspects and parameters. They might not be necessarily new, but cloud-based testing might exacerbate them.

The challenges of cloud based testing encompasses:

i) Integration issues can be difficult due to the existence of several environments.
ii) Lack of standards: Presently there are no standard/universal means to join together public cloud resources with consumer companies' data center resources.
iii) Test data is difficult to manage, for instance data creation and data masking.
iv) Service Level Agreements (SLAs) are difficult to reach: Terms and conditions of cloud-based testing service are at times hard to understand, and in most cases they are misleading as well as biased towards the vendor.
v) Usage: Misuse/improper usage of cloud-based test environments can further costs.
vi) Defect isolation plus resolution is a bit complex
vii) Planning: Thorough planning for test environments is required, spanning from utilization all the way until disassembly. Associated costs should also be taken into consideration for instance that of data encryption prior to set up testing task into a cloud environment. Cloud resources utilization monitoring is also of great importance so as to stay away from over-usage as well as over-payment.
viii) Performance: Since public clouds are shared by a number of various users, there may be instances where there is need to wait for necessary bandwidth. It might as well happen that a service provider suddenly announces disorder of a service as a result of maintenance window and/or network outage.
ix) Regulatory as well as legal compliance.
x) Third-party reliance services on responsibilities and roles bring a dependency syndrome.
xi) Currently there are no universal standard means to integrate users' internal data centers with public cloud resources, hence the pricing mechanisms and operating model differs from one cloud service provider to the other, and this becomes challenging.
xii) Security: The fact that data and code can be stored in a remote location outside organizations' regulatory and legal jurisdiction brings security as a major concern.
xiii) Infrastructure requirements: Infrastructure requirements must beset in a professional way because the flexibility that is offered by cloud based testing environments can turn out to be itself a risk if the requirements for the environments are not appropriate, so it must be done with great caution.
xiv) Dependency on the Internet: Each time any testing activity needs to be carried out, there is need to use the internet, hence there is such a high reliance on the internet.
xv) Testing all layers: Testing network connections, database, software applications, and server performance adds multiple layers near testing. There is a great need for testers to test for the communication between various layers in terms of the connection between the elements, and risks that might be encountered thus proper planning is needed. For example, if the internet connection breaks mid-way, the server goes down or the software crashes. All these have to be tested beyond what testers can physically manage in their environment.

VI. CONCLUSION AND FUTURE WORK

Cloud-based testing hasturned out to be a subjectof concern in the cloud computing as well as software engineering domain. Cloud technology plus testing as a service progresses with such a terrific speed hence more exploration work needs to be done to tackle issues, gaps and challenges in cloud based testing.Cloud based testing offers organizations higher flexibility with lower costs. Cloud models offer reduced budget and higher ROI-(Return on Investment), this is what is fuelling the growth of cloud based testing. The fact that cloud based testing is a recent technology with numerous pros should trigger organizations to can carry out pilot projects to fully explore the potential benefits of cloud-based testing. Pilots are a less risky way to evaluate the viability of testing in the cloud. Another safe way for organizations to explore cloud-based testing is to come up with elaborate strategies. This can include establishing criteria for applications for testing, potential cloud vendors, and test levels. Simulation exercise can also lead to new insights that may be used to get better the service performance of such real world applications, and in this regard we look forward to perform cloud based performance simulation tests (incorporating these parameters with great easiness) using available different tools that accommodate improvements and make some further analysis.

REFERENCES

[1]. Priyanka, I. Chana and A. Rana, Empirical Evaluation of Cloud-based Testing Techniques: A Systematic Review, ACM SIGSOFT Software Engineering Notes 37 (3), 2012, 1-9
[2]. S. Gaisbauer, J. Kirschnick, N. Edwards, and J. Rolia, Vats: Virtualized-Aware Automated Test Service, QEST, 2008, 93-102
[3]. M. A. S. Netto, S. Menon, H. V. Vieira, L. T. Costa, F. M. de Oliveira, R. Saad, and A. Zorzo, Evaluating load generation in virtualized environments for software performance testing, Proc. IEEE International Symposium on Parallel and Distributed Processing Workshops and PhD Forum, Washington, DC, USA, 2011, 993-1000
[4]. L. Gu and S. C. Cheung, Constructing and testing privacy-aware services in a cloud computing environment: challenges and opportunities, Proc. 1st ACM Asia-Pacific Symposium on Internetware, 2009, 2:1-2:10

[5]. P. Zech, Risk-based security testing in cloud computing environments, Proc. 4th IEEE International Conference on Software Testing, Verification and Validation, Washington, DC, USA, 2011, 411-414

[6]. T. Banzai, H. Koizumi, R. Kanbayashi, T. Imada, Hanawa, and M. Sato, D-cloud: Design of a software testing environment for reliable distributed systems using cloud computing technology, Proc. 10th IEEE/ACM International Conf. on Cluster, Cloud and Grid Computing, Washington, DC, USA, 2010, 631-636

[7]. H. Le, Testing as a service for component-based developments, Proc. 3rd International Conf. on Advances in System Testing and Validation Lifecycle, IARIA, 2011, 46-51

[8]. W. Chan, L. Mei, and Z. Zhang, Modeling and testing of cloud applications, IEEE Services Computing Conference, Asia-Pacific, 2009, 111 -118

[9]. A. Bertolino, G. Angelis, L. Frantzen, and A. Polini, Model-based generation of testbeds for web services, Proc. 20th IFIP TC 6/WG 6.1 Springer-Verlag International Conf. on Testing of Software and Communicating Systems, Berlin, Heidelberg, 2008, 266-282

[10]. A. Bertolino, W. Grieskamp, R. M. Hierons, Y. L. Traon, B. Legeard, H. Muccini, A. Paradkar, D. S. Rosenblum, and J. Tretmans, Model-Based Testing for the Cloud, 2010, 1-11

[11]. A. Jaaskelainen, M. Katara, A. Kervinen, H. Heiskanen, M. Maunumaa, and T. Paakkonen, Model-based testing service on the web, Proc. 20th IFIP TC 6/WG 6.1 Springer-Verlag International Conf. on Testing of Software and Communicating Systems, Berlin, Heidelberg, 2008, 38-53

[12]. M. Oriol and F. Ullah, Yeti on the Cloud, Proc.3rd IEEE International Conf. on Software Testing, Verification, and Validation Workshops, Paris, 2010, 434-437

[13]. S. Bucur, V. Ureche, C. Zam r, and G. Candea, Parallel symbolic execution for automated real-world software testing, Proc. 6th ACM Conf. on Computer systems, New York, NY, USA, 2011, 183-198

[14]. L. Ciortea, C. Zam r, S. Bucur, V. Chipounov, and G. Candea, Cloud9: A Software Testing Service, ACM SIGOPS Operating System Review, 2010, 5-10

[15]. J. Gao, X. Bai, and W. T. Tsai, Cloud-Testing: Issues, Challenges, Needs and Practice, International Journal on Software Engineering, 1(1), 2011, 9–23

[16]. X. Bai, M. Li, B. Chen, W.T Tsai, J Gao, "Cloud Testing Tools", Proc. 6th IEEE International Symposium on ServiceOriented System

[17]. Engineering (SOSE), 2011, 1-12

[18]. M.A.S Netto, S. Menon, H. V. Viera, L.T. Costa, F.M. de Oliveira, R. Saad, and A. Zorzo, "Evaluating load generation in virtualised

[19]. Environments for software performance testing," Proc. IEEE International Symposium on Parallel and DistributedProcessing Workshops

[20]. And PHD Forum (IPDPSW), Washington, DC, USA, 2011, 993-1000

[21]. Sebastian Gaisbauer, J.K irschnick, N Edwards, and J. Rolia, Vats: Virtualised-Aware Automated Test Service, 5thInternational

[22]. Conference on Quantitative Evaluation of Systems,QEST, 2008, 93-102.

[23]. J. Wu, C. Wang, Y. Liu, L. Zhang, AGARIC - a Hybrid Cloud based Testing Platform,IEEE- International Conference on Cloud andService Computing, 2011, 87-94

[24]. K. ˙Incki, I. Arı, H. Sozer, A Survey of Software Testing in the Cloud, IEEE 6th International Conference on Software Security andReliability Companion, 2012, 18-23

[25]. X. Wang, B.Wang, J.Huang, Cloud computing and its key techniques,IEEE International Conf. on Electronic and Mechanical Engineering and Information Technology , 2011, 320-324

[26]. Spirent, "Sthe ins and outs of cloud computing and its impact on the network, T." Spirent Whitepaper. Available at: http://www.spirent.com/media/White,2011.

[27]. L.R. Kalliosaari, O. Taipale and K Smolander, Testing in the Cloud: Exploring the Practice,IEEE software,2012, 46-51

[28]. N. Mehrotra, View Point-Cloud testing versus Testing a Cloud, 10th Annual International Software Testing Conference, InfoSys2011, 1-8