

# A Comparative Study on Various Software Testing Techniques in Cloud Computing

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## Abstract

Software testing in cloud is a type of testing in which web applications utilize cloud computing environment and base to reproduce genuine client movement by utilizing cloud advances and arrangements. It fundamentally adjusts to idea of cloud and SaaS. Cloud testing furnishes with the capacity to test cloud by utilizing the cloud base, for example, equipment and data transfer capacity that all the more nearly reproduce genuine conditions and parameters. In straightforward words, testing a Cloud indicates to the check and acceptance of utilizations, situations and foundation that are accessible on interest by adjusting these to the desires of the cloud computing plan of action. The main aim of this paper is to compare software testing techniques in the cloud computing environment. These software testing techniques could speed up the test efficiency and lessen down the time, cost, resources and the work of test engineers, making the fault tolerance higher. The use of these testing techniques in cloud computing environment a more efficient and effective solution when compared to traditional methods. However, due to the very large scale and computational complexity, there are some inherent challenges for conducting extensive testing which are also taken into consideration.

**Keywords:** *Software Engineering, Software Testing, Cloud Computing, SaaS, PaaS, IaaS.*

## 1. Introduction

Cloud computing is a style in which powerfully versatile and regularly virtualized assets are given as an administration over the Internet. It is intertwined with matrix figuring, utility processing, circulated registering, parallel processing, system stockpiling advancements, virtualization, and load parity and so on. In an average application arrangement of cloud computing, there are six layers' parts - customer, administration, application, stage, stockpiling and base. A cloud customer comprises of PC equipment and programming, which depended on cloud computing for application conveyance, or which is particularly intended for conveyance of cloud administrations. Cloud administration incorporate "items, administration and arrangement that are devoured continuously" over the system. A cloud application influences the cloud in programming engineering, to

dispose of the need to introduce and the application on the clients nearby PCs. A cloud stage encourages arrangement of utilization without the expense and multifaceted nature of dealing with the basic equipment and programming layers. Cloud computing is a general term for anything that includes conveying facilitated administrations over the Internet. These administrations are extensively partitioned into three classifications: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). Base as-a-Service gives virtual server occurrences extraordinary IP addresses and pieces of capacity on interest. Clients utilize the supplier's application program interface (API) to begin, stop, get to and arrange their virtual servers and capacity. In the undertaking, cloud computing permits an organization to pay for just as much limit as is required, and bring more online when Enquired. Since this pay-for-what-you-utilize model looks like the way power, fuel and water are devoured; it's occasionally alluded to as utility figuring. Stage as-an administration in the cloud is characterized as an arrangement of programming and item advancement devices facilitated on the supplier's framework. Designers make applications on the supplier's stage over the Internet. PaaS suppliers might utilize APIs, site entrances or passage programming introduced on the clients' PC. Engineers need to realize that right now, there are not norms for interoperability or information compactness in the cloud. A few suppliers won't permit programming made by their clients to be gotten off the supplier's stage. In the product as-an administration cloud show, the seller supplies the equipment framework, the product item and collaborates with the client through a front-end gateway. SaaS is an exceptionally expansive business sector. Administrations can be anything from Web-based email to stock control and database handling. Since the administration supplier has both the application and the information, the end client is allowed to utilize the administration from anyplace. A cloud can be private or open. An open cloud offers administrations to anybody on the Internet. (At present, Amazon Web Services is the biggest open cloud supplier.) A private cloud is a restrictive

system or a server farm that supplies facilitated administrations to a predetermined number of individuals. At the point when an administration supplier utilizes open cloud assets to make their private cloud, the outcome is known as a virtual private cloud. Private or open, the objective of cloud computing is to give simple, adaptable access to registering assets and IT administrations.

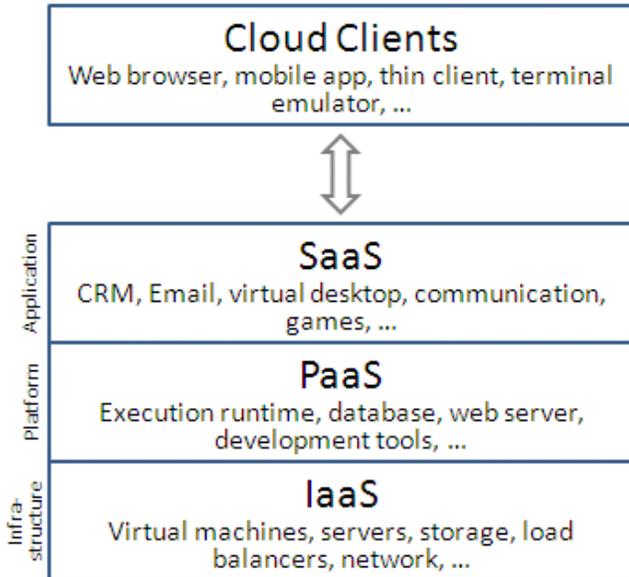


Figure 1: Classification of Cloud Computing.

## 2. Various Testing Techniques

Different sorts of testing required for a cloud setup which fundamentally classify into three structures: Functional or Purposeful testing, Non Functional or Non Purposeful testing and Ability or Capability testing Technique.

### 2.1 Functional or Purposeful Testing

Useful cloud computing testing is performed for both remote and nearby applications. Practical cloud testing is the trying of the considerable number of elements and elements of a framework which incorporates equipment and programming. It is directed on a complete, coordinated programming stage to check it's consistence with the prerequisites. In practical cloud testing, the procedure of check is done against framework details or necessities are done in cloud rather than on-reason programming testing. Practical testing is not sufficiently exhaustive to recognize every one of the blends of a site will be subjected to and its execution under anxiety conditions.

### 2.1.1 System or Framework Testing

Framework testing strategies is utilized to demonstrate the frameworks conduct inside of its own limits. It is basic to demonstrate that the framework capacities as it has been outlined when the framework parts cooperate, inputs and yields are of course and the general coming about framework is a great cloud framework.

### 2.1.2 Integration or Reconciliation Testing

Reconciliation cloud testing permits the business to confirm the cloud arrangement will work inside of the present foundation and situations which eventually demonstrating that the usage of a cloud arrangement does not negatively affect any current frameworks. Mainly all the business prerequisites must be checked and accepted to demonstrate that the finished consequence of the Cloud arrangement will meet the recorded needs of the business.

### 2.1.3 User or Client Acceptance Testing

Client Acceptance Testing will be done to demonstrate that conveyed cloud arrangement meets business necessities so that the client acknowledges the created cloud arrangement. Client acknowledgment testing is done on both on-reason and off-reason. Be that as it may, the on location testing permits quick control and observing of test progress.

## 2.2. Non-Functional Testing

This testing is done to guarantee that a web application meets the predetermined execution necessities. Non-useful testing strategy is additionally known an execution testing method. In cloud, the applications versatility degree is much more extensive than in ordinary execution testing systems.

### 2.2.1 Business Requirement Testing

Before moving their business to a cloud computing arrangement, the associations and coordinates should deliberately dissect and record their business necessities unmistakably, exact and unambiguously. Business prerequisites are establishments for building a cloud computing arrangement. These business prerequisites can be accomplished through surveys, periodical client meets and workshops. Later, this thus gives an impeccable framework is built which is equipped for conveying the business prerequisites. Cloud Availability Testing Cloud administrations must be accessible for all times. There ought to be likewise certification that the there is no sudden downtime such that the matter of the customer must not be antagonistically influenced.

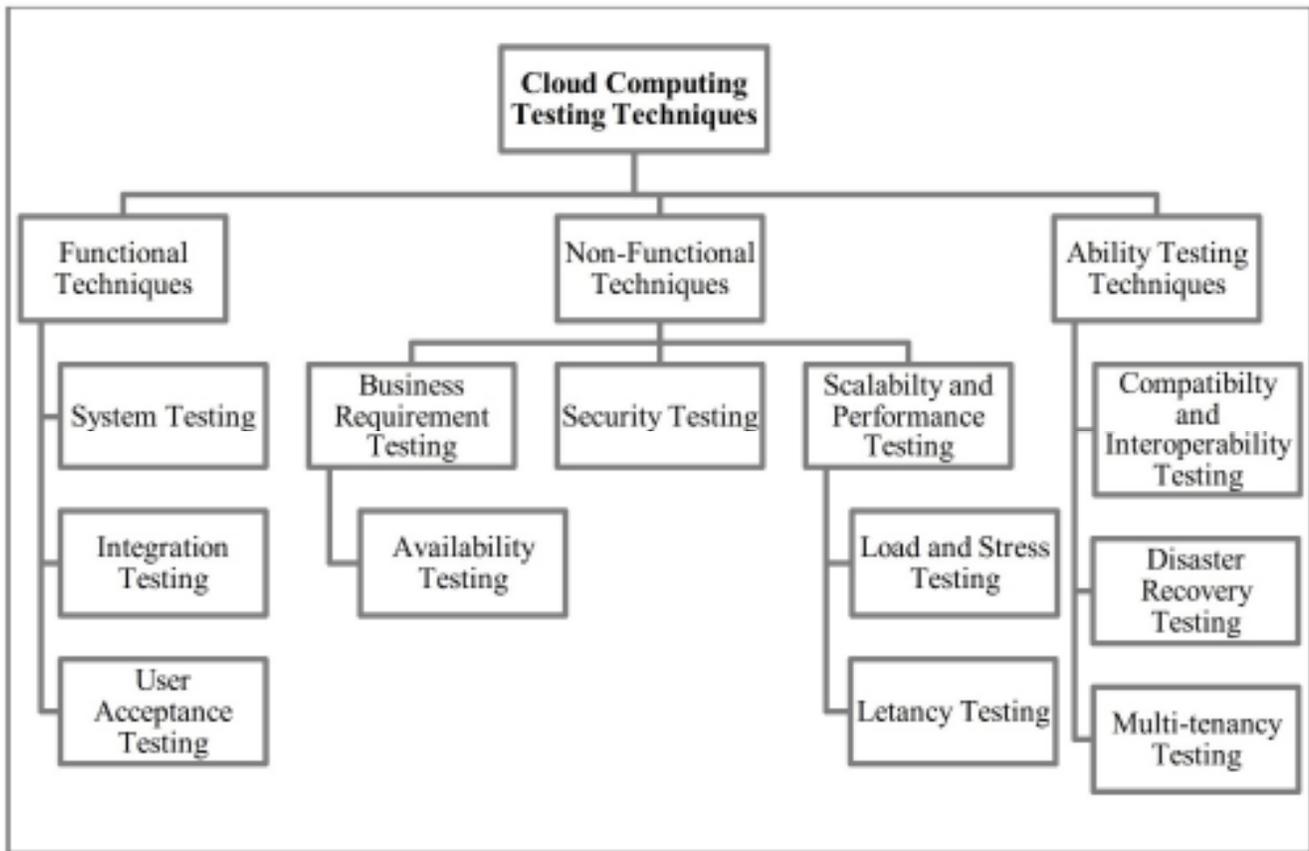


Figure 2: Various Testing Techniques.

### 2.2.2 Cloud Security Testing

Security testing which is an irreplaceable piece of testing applications because of expansion in security ruptures in business. This can give confirmation that business basic information is put away and transported securely. To recognize strategies for using so as to access a framework regular devices and procedures utilized by programmers can extremely well ensure the security of Cloud arrangements.

### 2.2.3 Cloud Scalability and Performance Testing

Cloud Scalability is another significant range of concern where satisfactory measure of testing is required. Cloud computing arrangements dependably claim to be adaptable on interest. Stack or Stress testing can be utilized to demonstrate that the created cloud arrangement can be scale as required with the assistance of programming instruments. Henceforth Cloud arrangement can be precisely measured and its ability is checked. Cloud Performance testing methods permit us to gauge the cloud frameworks execution precisely. Execution testing with the heap testing strategies

permits getting a precise picture of the arrangement's capacity on the cloud.

Execution is for the most part fixing to an application's capacities inside of the cloud foundation. Discovering edges, bottlenecks and confinements is a piece of execution testing. For this, testing execution under a specific workload and fluctuate the way of activity on-interest is vital. A Cloud Load and Stress Testing Application dependability is a main consideration as the client check is relied upon to be increments. Load testing of an application includes making of overwhelming client activity and measuring its reaction. There is likewise a need to tune the execution of any application to meet certain gauges. Measure reaction times and seclude issues identified with particular activities while framework is subjected to expanding load from different areas and multi-client operations. It is basic to recognize issues as framework is tried to limits most extreme expected limit or regularly past the normal use. Stress Test is utilized to decide capacity of utilization to keep up a specific level of viability past limit or most extreme expected limit or past

the normal use. It is key for any application to work even under over the top push and look after strength. Stress creating so as to test guarantees this top burdens utilizing test systems. However, the expense of making such situations is colossal. Inactivity Testing Cloud testing is used to quantify the dormancy between the activity and the relating reaction for any application subsequent to sending it on cloud.

**2.3. Ability or Capacity Testing Techniques**

Capacity testing is done to guarantee that the cloud environment can gives its administration on-interest to clients. In this classification, the similarity, interoperability and multi-tenure capacity of distributed computing environment is tried.

**2.3.1 Similarity and Interoperability Testing**

In cloud environment, diverse programming and working frameworks is utilized and made on interest which makes the similarity testing must. A cloud application must proficient to work and executed over numerous situations and different cloud stages. Henceforth, it is anything but difficult to relocation of a cloud applications and stages starting with one framework then onto the next foundation.

**2.3.2 Calamity Recovery Testing**

The cloud administration supplier has dependably lean towards that his cloud administrations must be accessible all an ideal opportunity to end-clients in any case it is not achievable. There might be some shot of disappointment so the fiasco recuperation time must be low. Cloud confirmation must be done to guarantee the administration is back online with least unfriendly impact on business.

**2.3.3 Multi-Tenancy Testing**

Multi-tenure testing guarantees that the different customers and associations utilizing on-interest administrations initiated at a given time. Cloud administration ought to be adjustable for every customer and give information and security level to keep away from any entrance related issue.

**3. Challenges Faced During Testing**

**3.1 Cloud Service Challenges**

The key test in distributed computing testing environment is the cloud administration challenges. The principal test in this class is administration accessibility without encountering undue postponements since client association is hoping to receive cloud benefits as opposed to keep up nearby establishments. Cloud administration must look and feel as nearby administrations instead of remote administrations. The second test is the cloud administration

confirmation. The cloud administrations supplier must guarantee auspicious conveyance of cloud administration and controls information correspondence association between cloud administration and corporate clients. The last test is administration proficiency. It includes productivity in all perspectives from cost investment funds, space and power effectiveness to proficient and versatile cloud administration conveyance utilizing virtualization, top of the line servers and rapid.

**3.2 Security Challenges**

Since data goes through the Internet, analyzers need to perform security testing to ensure there is no information spillage when information is sent over the Internet. Security in people in general cloud is still a noteworthy issue.

Table 1: Various Challenges in Testing

Challenge Category	Challenges
Service Challenge	<ol style="list-style-type: none"> <li>1. Service Availability</li> <li>2. Service Assurance</li> <li>3. Service Efficiency</li> </ol>
Security Challenge	<ol style="list-style-type: none"> <li>1. Confidential Data Security</li> <li>2. Depending on customer data</li> <li>3. Meeting Security Requirements</li> </ol>
Layered Testing Challenge	<ol style="list-style-type: none"> <li>1. Three layers testing Protocol</li> <li>2. Communication between Layers</li> </ol>
Lack of Universal Standard and Infrastructure	<ol style="list-style-type: none"> <li>1. Limited Technology configuration</li> <li>2. Limited Servers and Storage Infrastructure</li> <li>3. Networks interconnectivity</li> <li>4. Virtualization level</li> </ol>
Guidance, Knowledge and Staff Expertise	<ol style="list-style-type: none"> <li>1. Obtaining Guidance</li> <li>2. Expertise Teaching Staff</li> <li>3. Acquiring Direct Knowledge</li> </ol>
Procuring Cloud Service on-Demand Basis	<ol style="list-style-type: none"> <li>1. Define Specific Quantity and Costs</li> <li>2. Dependency on Remote Installed Applications</li> <li>3. Increasing Expenditure on Encrypted Data</li> </ol>
Other's Challenges	<ol style="list-style-type: none"> <li>1. Planning of Test Environment</li> <li>2. Accrediting Vendors which meets Standards</li> <li>3. Ensuring Data Portability and Interoperability</li> <li>4. Proper Utilization of Cloud Resources</li> </ol>

The primary test in this classification is the security of the private information. There might come up the circumstance about the spillage of private data, web suspending, and abruptly disturbance of administration because of an

upkeep window, moderate web speed, infection assault. The second test is some test strategies are relying on the client information. All together for successful testing to occur, some testing undertakings depend profoundly on the genuine client or generation information. Now and again, the clients are denied from supplying classified or creation information to outsiders. So the test information ought to be doubly examined for testing in cloud. The third test is meeting security prerequisites. Cloud sellers may not be acquainted with security necessities that are remarkable to government offices, for example, consistent checking and keeping up a stock of frameworks.

### 3.3 Layered Testing Challenges

The third real test class is the trying at numerous layers of the cloud environment. The primary test in this is the layers testing Protocol. In this, the testing system association, server execution, database and programming application adds various layers to cloud testing. Analyzers need to test past what they can physically control in their surroundings. Second test in this is the keeping up correspondence between layers. In this, Testers need to test the correspondence between the layers, test association between the components furthermore get ready for the dangers, for example, association breaks halfway, server down and programming crashes.

### 3.4 Absence of Universal Standards

Base The fourth test classification is the absence of benchmarks and constrained foundation in broad daylight cloud environment. The primary test in this is the absence of all-inclusive principles. Right away, there are no legitimate all-inclusive standard answers for coordinate open cloud assets with client organization's inside server farm assets. Open cloud suppliers have their own particular engineering, working models, estimating instruments and offer next to no interoperability. This prompts a major test for organizations when they have to switch sellers. The second test in this is the restricted framework. Some cloud suppliers offer just constrained sorts of designs, innovation, servers, stockpiling, systems administration and transfer speed which making it hard to make ongoing test situations.

Table 2: Layered Approach

Layer Number	Layer Name
Layer 3	Database and software applications
Layer 2	Server Performance
Layer 1	Network Connection

### 3.5 Acquiring Knowledge and Staff Expertise

The fifth test classification is the getting direction, learning and staff skill. The main test in this is the Obtaining

direction for testing cloud administration. Existing government direction for utilizing cloud administrations is inadequate or fragmented. Offices referred to various zones where extra direction is required, for example, obtaining IT thing and surveying data security administration with security levels. The second test is the taking ability educating staff. Administration supplier might not have the essential devices or assets, for example, skill staff to actualize cloud arrangements. Showing their staff, a totally new arrangement of procedures and instruments, for example, observing execution in a cloud situation has been a test. A third test is the gaining direct learning. Conveying cloud administrations without direct learning of the innovations and apparatuses has been a test.

### 3.6 Cloud Services on-Demand Basis

The 6th testing challenge class is the obtaining cloud administration on the on-interest premise. The principal test in this is the conveying on-interest administrations with particular amount and expenses. The on-interest and versatile nature of cloud administrations can be hard to characterize particular amounts and expenses. These instabilities make contracting and planning challenge on account of the fluctuating expenses connected with versatile and incremental cloud administration acquisitions. The second test is the reliance on remote introduced applications. Since applications are not introduced locally in controlled situations. This makes it harder for analyzers to imitate the client environment. The third test is the expanding consumption on scrambled information. Despicable use of cloud based test situations can expand costs.

### 3.7 Other Challenges

The seventh testing challenge class contains some other's difficulties identified with testing a distributed computing environment. The principal test in this is the arranging of test environment and overcome social boundary. Testing groups ought to thoroughly arrange their test surroundings from usage periods through dismantling with the consciousness of the related costs, for example, expense of encoding information, before placing testing in a cloud domain, since these prerequisites will expend extra CPU and memory. Association society might likewise go about as a snag to executing distributed computing arrangements. The second test is the certifying sellers which meets measures. Association might not have a system for confirming that sellers meet principles for security on the grounds that the danger and approval administration program had not yet achieved introductory operational capacities. Third test is the guaranteeing information convenience and interoperability. To safeguard their capacity to change sellers later on, organizations might endeavor to dodge stages or innovations that bolt clients

into a specific item. Forward test is the best possible usage of cloud assets. It is critical to screen use of cloud assets to keep away from over-use and over-installment.

#### 4. Comparative Analysis

The significant difference between functional and non-functional testing is this: Functional testing guarantees that your item meets client and business prerequisites, and doesn't have any real bugs. Then again, non-functional testing needs to check whether the item faces client's demands. Fundamentally, functional or practical testing is intended to discover that the application's components and operations perform the way they ought to. Non-practical or functional testing needs to realize that the item "carries on" accurately. Your application needs to pass both classes of testing to guarantee that your shoppers have a decent involvement with your item. Inability to discharge a working item that addresses the issues of buyer requests can harm your organization's notoriety and lessen general item deals.

In addition, functional testing manages necessity documentation and typically answers the topic of "can the client do this?" or "does a particular element will work or not?" Then again, non-useful testing will you decide the drop point, which is only a time when extremes of adaptability or execution prompts temperamental execution. Aside from all these, there are numerous ways useful or functional and non-useful or non-functional testing varies from one another. Here're a couple purposes of examination:

For Functional:

- i. Here, testing created application against business necessities.
- ii. Functional testing is completed with the assistance of utilitarian details gave by the customers or with the assistance of utilizing the configuration particulars like use cases gave by the planning group of the task.
- iii. Usually useful testing covers taking after sub-sorts of testing's.
- iv. Unit Testing: It is a standout amongst the most helpful testing strategies that is valuable to distinguish and decide bugs and blunders right from the earliest starting point of the product advancement life cycle.
- v. Smoke Testing: It is only another sort of testing that is frequently called manufacture check testing, which includes an arrangement of non-thorough tests that ensure that the most essential capacity inside of the application works impeccably.

- vi. Sanity testing: It is an unscripted kind of test, which focuses on a couple of practical zones of an application.
- vii. Integration testing: It is a kind of test which tests the applications all in all to recognize if there is any bug presents there in the connection between the coordinated units of the application.
- viii. Usability Testing: It is only an assessment strategy, which is utilized to make that the client is fulfilled by the application created.
- ix. Apart from this, practical testing additionally includes a couple of more sorts of testing techniques like interface testing, framework testing, relapse testing and client acknowledgment testing.
- x. It is conceivable to utilize both manual and in addition mechanization testing device for practical testing. In any case, it relies on upon the instrument utilized or the practice actualized as a part of manual testing.
- xi. Functional testing includes examining client orders, information control, looks, client screens and mix of the frameworks.

Non-Functional Testing:

- i. It is very surprising from the practical testing. Tests the application taking into account the customer and execution necessities.
- ii. Non-utilitarian testing is normally done with the assistance of the necessities and test situations characterized by the customer.
- iii. Non-useful testing includes taking after sub-sorts of testing.
- iv. Compatibility Testing: It offers you some assistance with determining the similarity of the applications with the figuring environment.
- v. Load Testing/Stress Testing: While adding to an application, it is critical for an analyzer to check whether the application or site can withstand the heap and stretch when there are numerous individuals evaluating it in the meantime or not.
- vi. Recovery Testing: It is critical for the analyzers to check for the capacity of an application to recoup once confronted equipment disappointment issues.
- vii. Security Testing: When your application obliges clients to give secret data, it is vital that you perform security testing as to ensure that the data gave by the client transmitted safely.
- viii. Volume Testing: It tests the application's execution with a particular arrangement of information.
- ix. Apart from these testing strategies, it uses a bundle of other testing approaches including accessibility testing, pattern testing, consistence testing and then some.

x. To make the non-practical testing powerful, it is vital to utilize testing apparatuses as opposed to testing it physically.

xi. Non-functional testing includes interoperability, similarity, convenience, and setup and introduce capacity.

#### Ability Testing:

Differing from above two this testing is done to guarantee that the cloud environment can give its administration on-interest to clients. So basically the ability testing assesses the similarity, interoperability and multi-tenure capacity of distributed computing environment is tried.

Thus, these are a couple of fundamental differences in the middle of all these testing techniques. Anyway, it depends on which one suits our task necessities.

## 5. Conclusion and Future Work

The development of cloud computing made an interest for benchmarks that can quantify the execution attributes of cloud applications. Testing groups should to equip themselves with practical methodologies to alleviate the issues connected with it and to compute extra abilities accessible in the cloud computing environment? A few couple favorable circumstances and a couple testing difficulties of the cloud computing arrangements have been recognized in this paper. In future, as it is getting more developed design for the cloud computing and more testing on the cloud applications, there is the plausibility of additional testing challenges which can be further investigated by researchers.

## References

- [1] NDSU Department of Computer Science, Software Testing Research Group, Jan. 2010, <http://cs.ndsu.edu/strg/>.
- [2] J. Hurwitz, M. Kaufman, and R. Bloor, *Cloud Computing for Dummies*, Wiley Publishing, Inc. 2010.
- [3] T. Vengattaraman, P. Dhavachelvan, R. Baskaran, Model of Cloud Based Application Environment for Software Testing, (IJCSIS)International Journal of Computer Science and Information Security, Vol. 7, No. 3, 2010.
- [4] AppLabs, *Testing the Cloud*, white paper, Internet: [http://www.applabs.com/html/TestingtheCloud\\_786.htm](http://www.applabs.com/html/TestingtheCloud_786.htm).
- [5] A.Y. Grama, A. Gupta, V. Kumar, Isoefficiency: Measuring the Scalability of Parallel Algorithms and Architectures, *IEEE Parallel and Distributed Technology*, 12-21, Aug. 1993.
- [6] L. Duboc, D. S. Rosenblum, and T. Wicks, A Framework for Modeling and Analysis of Software Systems Scalability, In 28th International Conference on Software Engineering (ICSE'06), May 20–28, Shanghai, China, 2006.
- [7] Y. Chen and X. Sun, STAS: A Scalability Testing and Analysis System, in *IEEE International Conference on Cluster Computing*. Available <http://ieeexplore.ieee.org/>, 1-10, 2006.
- [8] G.Candea, S. Bucur, and C. Zamfir, Automated software testing as a service, In the 1st ACM symposium on Cloud computing (SoCC '10), 2010.
- [9] L. Ciortea, et al, Cloud9: a software testing service, *ACM SIGOPS Operating Systems Review*, vol. 43, no. 4, January, 2010.
- [10] P. Williams, Value versus cost: governing IT on a reduced budget!, *ComputerWeekly.com*, Friday 08, February 2002.
- [11] A.Y. Grama, A. Gupta, V. Kumar, Isoefficiency: Measuring the Scalability of Parallel Algorithms and Architectures, *IEEE Parallel and Distributed Technology*, 12-21, Aug. 1993.
- [12] L. Duboc, D. S. Rosenblum, and T. Wicks, A Framework for Modeling and Analysis of Software Systems Scalability, In 28th International Conference on Software Engineering (ICSE06), May 20–28, Shanghai, China, 2006.
- [13] Y. Chen and X. Sun, STAS: A Scalability Testing and Analysis System, in *IEEE International Conference on Cluster Computing*. Available at <http://ieeexplore.ieee.org/>, 1-10, 2006.
- [14] G. Candea, S. Bucur, and C. Zamfir, Automated software testing as a service, In the 1st ACM symposium on Cloud computing (SoCC '10), 2010. Sharma et al., *International Journal of Advanced Research in Computer Science and Software Engineering* 4(6), June - 2014, pp. 772-777.
- [15] L. Ciortea, et al, Cloud9: a software testing service, *ACM SIGOPS Operating Systems Review*, vol. 43, no. 4, January, 2010.