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Case Study

Towards Software Testing as a Service for Software as a Service Based on Cloud Computing Model

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Abstract: Cloud computing is an advance technology paradigm that permits ubiquitous access to shared pools of higher level advance services from different sources at single point services that is quickly administered with minimal managing effort through the Internet. As Cloud computing relies on shared resources to attain consistency, monitoring and potency issued to store, manage and processes data on the internet. For improving and providing facilities in Cloud, service models such as Infrastructure as a Services (IaaS), Platform as a Services (PaaS) and Software as a Services(SaaS), are used. Consequently, efforts must be done as not enough work exists which can describe maintenance and assessment of applications test suite on cloud environment especially in services model SaaS assessment and for testing in cloud use Testing as a Services (TaaS) as a third-party service to end users. As these models are providing two different services environments, their evaluation is a difficult task for engineers. In this research, we use testing layers in SaaS model to increases the efficiency of software testing requests while using SaaS applications by introducing archetype of TaaS layers merging SaaS over cloud for software testing. Consequently, this research provides prototyping in cloud-based testing for SaaS. The case study is used as an empirical evaluation method for our approach to test software in TaaS infrastructure with properly and precisely defining five layers using cloud environment, by introducing to accomplish the requirements testing and evaluation through SaaS. The results show that our proposed framework improves the testing activities and makes the evaluation process more efficient for engineers.

Keywords: Cloud computing, Software Testing and Quality, Software as a Service (SaaS), Testing as a Service, (TaaS), Scheduling and Dispatching.

1. INTRODUCTION

Cloud computing is an archetype of computing; a new way of rational about information industry but not any explicit technology. In cloud environment (CE) users do not care about how it works or about its physical infrastructure; they only care about the services and services quality. CE provided more scalability and elasticity, more availability and reliability, more manageability and interoperability, more accessibility and portability, and more performance and optimization. CE provides three different types of service models i.e. infrastructure as a service (IaaS), platform as a Service (PaaS) and services as a services (SaaS) [1].

These services provide different level of services from development to users. IaaS provides users services of resource management and system monitoring interfaces. e.g. Amazon EC2, Open Stack (Open Source); whereas, PaaS provides users capability for applications deployment on IaaS using programming languages and tools supported e.g. Microsoft Windows Azure, Google App Engine and SaaS provided running applications which accessible from various client devices e.g. web browser, web-based email, Google Apps etc. instead of handling or controlling the underlying cloud infrastructure.

SaaS provides ready to use services, which demand strong testing for high quality and reliability [2]. The testing in SaaS is done through testing as services (TaaS), in which testing facilities are acquired from a third party [3]. There are three types of TaaSi.e. Functional (integrated, regression

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and automated testing), performance (deal with multiple users thru virtualization) and security (check susceptibility in application and web portal) [1-2]. TaaS is flexible and readily accessible. It guarantees information authenticity and reduces operational costs; is easily maintainable and functions based on pay as per use. There are some back draws, however. For example, different clouds are used for SaaS and TaaS, so performance issues can occur. Problem of job scheduling, resource management and dynamic arrangement of processes can arise as well [3-7].

Therefore, TaaS is still a new paradigm for researchers and industrial practitioners to deal with challenges of TaaS [3, 7-8].Consequently, in our study we mainly focused on TaaS and its framework to elaborate requirements for supporting computerized and automated cloud based testing relevant to SaaS applications. So, we addressed four major issues in this paper. These issues are; (Performance Maintenance) Different testing tasks submitted to TaaS platform by test tenants, processes, directly allocating separate testing environment to different tenants will acquire significant cost and time. A solution is not increased the performance by decreasing the time and cost in terms of various techniques; (Clustered tasks and Scheduling**)** the levels of agreements for example limit limitations are acquired by different tenants. Besides this problem, there is ambiguity of tough processes. Such as, due to communication errors in cloud testing and system break down, the priority of processes are dynamically amend and slack times will modernize. In addition, testing services is hosted on a group of virtual machines with dissimilar aspects by TaaS cloud; (Oversee resource testing and task position) Monitors has provided by TaaS platform that can provide information related to status including scheduler that maintain the task queue to choose the processor or virtual machines for test implementation; (Dynamically arranging cloud processes, processors and Virtual Machines (VM) produces great flexibility and elasticity. In this case un availability of VM due to fully occupation of existing VMs, request that will send by scheduler to build a new VM to process a new job. When Virtual machine skilled its tasks, the VM will be discharged authority sending by monitor.

Additionally, we manage these issues with our proposed framework as; Increasing the performance of testing over cloud and manage tasks more efficiently; By merging TaaS and SaaS and its supporting test structure, it improves the performance in all levels of testing; The tasks are scheduled and clustered in a way that the testing goal and objectives can be achieved efficiently; All tasks and testing resources must be managed and According to scheduling decisions organizes cloud resources which include the creation, maintenance and migration of processes and processors at runtime.

1.1. Objectives

This paper evaluated the software testing in TaaS infrastructure with appropriately defining five layers using cloud environment come into existence to congregate the requirements in SaaS testing and evaluation. The two algorithms that are dispatching and scheduling, were introduced to enhance usage of tasks and requirements. In this work, we are introducing a model over cloud of TaaS layer integrating SaaS.

1.2. Research Questions

Following research question constructed to improve testing performance using TaaS as SaaS.

RQ1: Is software testing in TaaS is successfully conducted?

RQ2: Is SaaS validation is improving the performance of software testing?

RQ3: Is Software testing will be improved by defining layers?

1.3. Related Work

In this section, we review existing literature to identify, classify, assess and understand the entirety of searching contents relevant to cloud computing services models i.e. TaaS and SaaS. In literature, we have found that there were many researchers who had taken into consideration in the field of software testing over cloud, but they did not focus on increasing the performance in terms of cost and time. By studying the literature review, we have figured out the problems depicted in Table 1.

1.3.1 Testing in Cloud Environment

By uniting the two research field this paper defines on an organized report of published attained outcome. Concerning major assistance, gaps,

Table 1. Identifying Issues of Current Software Testing

ISSUES	DESCRIPTION
Less focused on Software testing	By reviewing previous literature, there were not focused on increasing the performance of software testing in terms of enhancing cost and reducing time.
Indistinct definition of SaaS based Testing	In the past, not clearly defined the prototype of SaaS based testing over cloud infrastructure.
Inept environment of software testing	There were no security measurements to conduct the software testing effectively.
Lack of Resource and Task management mechanism	There was not an effective mechanism to control and manage the resources and tasks over TaaS layers and SaaS testing structure.

opportunities trends, potential research guidelines and challenges, a general idea is being offered [1-7]. Soon the software tests and Cloud compute and are expected to be widely accepted research areas and concepts. For cloud established techniques of software testing are being used. On the contrary, there is a great evaluation in cloud compute and for software testing research, the new opportunities and challenges are being emerged.

In this paper the arrangement of present research study was presented, searched the association of software test with dissimilar procedure structure of cloud compute and acknowledged gaps in the literature. It will provide a great advantage to researchers to explore new strengths and select their research path. It has been witnessed that approval testing provides an opportunity for testing. For advance research, managing test of tasks is among the possible fields [8-12].

To sum up , interoperability testing requirements is which provides services composition by merging services deliverance structures. In cloud computing, we mainly focus on satisfying these gaps for having a wide-ranging verification and validation model. The issue will be addressed that enhance cloud as a proposal for unit testing and for extra proliferated utilize over the cloud, we will also spotlight existing computerized test tools.

1.3.2 TaaS on Clouds

The phenomena of Cloud computing TaaS for clouds, applications that are cloud based and for SaaS which results enhance into new challenges and business features resulting in different scenario related to service models, requirements and testing techniques [7, 13-14]. A widespread discussion group on TaaS in cloud computing is evaluated by this paper. The engineers and managers raised the questions that are answered by this paper which defines conceptual discussions based on TaaS, which includes its objectives, scope, values and direction, goals, testing environments, unique features as well as required techniques. In county, it checks original challenges, issues and evolving requirements [14-15].

TaaS is appropriate a major investigate topic in both software engineering and cloud computing examine groups. Due to the advancement of cloud-based knowledge and TaaS, for unlocking problems and difficulties on TaaS, techniques, infrastructures and mechanization solutions further research results are needed. Besides this, it also emphasizes on discussion based on TaaS and necessities and different aspects. Furthermore, it spotlights the main dissimilarities between cloud based TaaS and conformist software testing [25, 17, 19].

Therefore, a comprehensive study was conducted to find out the effects of different TaaS practices benefits in SaaS environment to improve the testing performance by proper load balancing, job scheduling, dynamic provisioning and monitoring.

2. MATERIALS AND METHODS

This paper merged the TaaS infrastructure with SaaS over cloud. It provides the general view of how the application is sent to a number of layers and receives by the clouds for the testing process. It emphasizes on the importance of the cloud computing structure through application environment. This paper prototyping in cloud based Testing for SaaS. This paper introduced SaaS agents to increase the performance of testing. Each agent performed individual tasks that communicate with TaaS layers over the cloud. This paper follows

scheduling and clustering algorithms, data mining technology. This paper increased the performance by decreasing the time and cost in terms of various techniques.

2.1 Proposed Work

This paper emphasized on the importance of SaaS validation and performance in cloud based TaaS infrastructure. It emphasizes on the important features of the cloud computing prototype using application situation. It provides the general view of how the application is sent to several layers and receives by the clouds for the testing process. In proposed framework we merged TaaS layers with SaaS for improving testing services at one place instead of using third party services for testing in a cloud based environment as shown in figure 1.

2.1.1. Architecture of Cloud TaaS

The TaaS architecture layers in cloud are: Contributor layer; Management layer for tasks testing; Management layer for resource testing; Test layer including testing service, testing service composition and so on and Testing Database layer.

2.1.2. Working on TAAS Tasks

In this paper there are two clouds. One cloud has TaaS Infrastructure and the other has SaaS

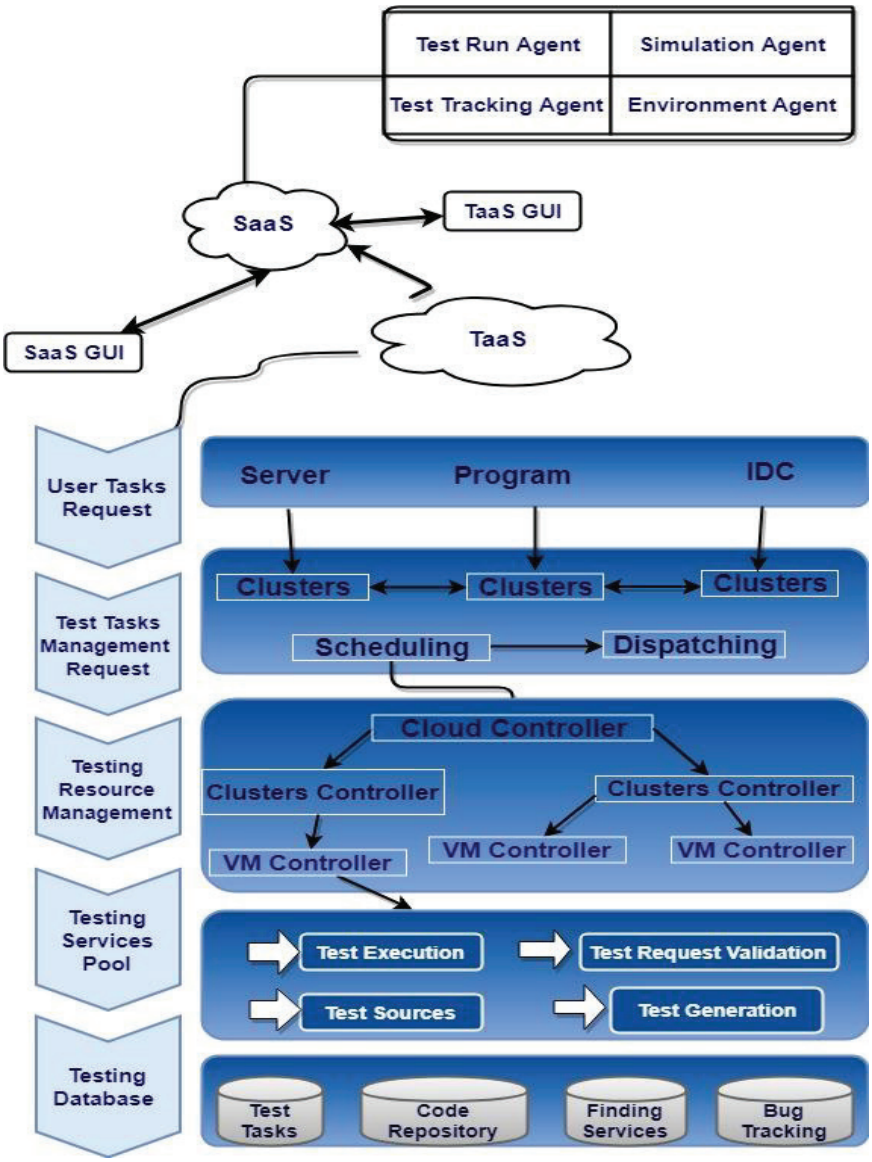

Fig. 1. Systematic Model for Software Testing using Cloud

2.1.2.1 User's test requests

This layer is the first layer. In this process and provides access to the TaaS platform. This layer is divided into two parts i.e. Test service tenants and contributors. This layer gets the tenants test requests by using IDE or any interface and ahead it to the next layer. They contribute layer publishes or deploys their services to TaaS platform. This paper increased the performance by decreasing the time and cost in terms of various techniques.

2.1.2.2 Management layer for tasks testing

The second layer receives the test request from tenants in the capability checking process. Capability checking means to check the TaaS platform's request. The second layer has clusters that used data mining techniques to store the selected data more effectively. The scheduler arranges the test tasks and allocates the test tasks to appropriate virtual machine. The scheduler also sends the scheduling test task to monitor in the third layer to monitor testing resources.

2.1.2.3 Management layer for resource testing

The second layer's scheduler offers monitor to maintain task queue to select processes and scheduler. It checks the physical machines, where as VMs gives resources according to request submitted by task. It allocates resource according to the job appeal. There are three sub layers of this layer: The preprocessing, the resource managing level, the computing node level (specific applications establish through the VM).Then the monitoring information is passed to the cloud controller. Each cloud controller controls the tasks identified by the tenants. It controls all the cluster controllers, for example, querying the cluster etc.

2.1.2.4 Testing service pool layer

Group of testing services for different forms of testing is hosted by Service pool, for example, test source service, unit testing, including test execution service, and result validation service. This layer presents matching rules, fault tolerance technology and scheduling test-task. This layer has four service pools i.e. Test completion, Test outcome validation, Source code testing and Generate code testing. This layer focused on providing services of test task execution properly. After testing, layer validates the results and source code. At the end generates the source code.

2.1.3 Testing Database Layer

It maintains and stores the test task request of tenants, bug tracking results. It played a very important role to conduct the software testing. This layer consists of four databases:

- Test tasks
- Code repositories
- Bug tracking

Each database stores and manages test requests more efficiently**.** These databases test the requests, stores the requests, test the services and also keep the track of bug in the requests.

2.1.4 SaaS Infrastructure

This paper also emphasized on SaaS infrastructure. In SaaS, there are four agents. The cloud based virtual test environment refers to deploy under-test Saas and its sustaining test structure which are: Test runs Agent, Test Tracking Agent, Simulation Agent and Environment Agent. The SaaS agents evaluated the test task requests and collaborate with seas to increase the security over the cloud. TaaS services emphasized on current TaaS before SaaS deployment. Amazon'sEC2 used in this project as the cloud infrastructure to sustain the environment that has based on virtual test and Server, even though the planned and on-going TaaS infrastructure with three-layers shows that they can be deployed on dissimilar cloud infrastructure:

2.1.4.1 User interface (UI) layer

This interface has two user interfaces:

I) SaaSUI and
II) TaaS UI

2.1.4.2 Test space layer

Cloud that has contains SaaS testing deployed through it and its behind test structure based on virtual test environment refers by the Test space layer, as well as the Tracking agent, Environment agent, Simulation agent and Test agent.

2.1.5. Merging TaaS Environment with SaaS Over Cloud

This paper proposed the software testing by using TaaS with SaaS. This increases the efficiency of software test requests. This paper prototyping in cloud based Testing for SaaS. This paper explains the layers of TaaS in detail focus on SaaS services and evaluate the software requirements in a TaaS environment over the cloud based system. In this

work, we are introducing a model of TaaS layers integrate SaaS over cloud for software testing. The TaaS environment merges with SaaS environment over the cloud. It emphasized on the importance of the cloud computing prototype through application atmosphere. This paper introduced SaaS agents to increase the performance of testing. Each agent performed individual tasks that communicate with TaaS layers over the cloud. By merging the TaaS with SaaS infrastructure increases the efficiency and effectiveness the software testing requests from users or clients. TaaS handles the user's requests with SaaS testing agents and pass it in all the layers and then stores in database repositories.

3. RESULTS AND DISCUSSION

To evaluate and understand the efficiency in the real time, multiple browser platform and types and different forms of hardware used in multiple operating systems. These hardware types evaluate and reconfigure the effectiveness in real time. For evaluation of our study we adopted case study evaluation method.

3.1. A Case Study

At San Jose State University, we offered students in a testing class (CMPE287) to investigate Orange Human Resource Management (HRM) system as the ideal Software as a testing function. To perceive the developed TaaS method (Cloud based TaaS) for SaaS validation. Orange HRM is presented as hosted SaaS application which is an open source. For both small and average enterprises, it can be easily located up and configured as their HRM service structure. These are the following functional services included by Orange HRM:

a) Identify and way organizational structure
b) pay-scale index
c) Depart management
d) Private information management
e) Worker service structure

For both features, by means of two black boxes efficient testing techniques there is need to design scheme stage test, which are:
i) Decision Table Testing
ii) Equivalence panel.

They require generating test scripts to generate test cases:
i) Test scripts based on functions
ii) Performance test scripts.

The test tools like Jemeter and Selenium supports Cloud based and with these test tools it can carry out test scripts. It is mandatory for the student groups to use cloud based TaaS system in the case study to do following steps:
i) Build a test task and its practical test room to set up Orange HRM SaaS program.
ii) To migrate and supervise test scripts into the test space.
iii) To execute automated GUI-based functional testing GUI-based test agent is used.
iv) Jemeter is used as a presentation test tool, large-scale by connecting automated presentation testing and scalability evaluation are conducted using pre-loaded performance and auto-test scripts.
v) As a testimony test computerization outcome is reported.

The results of case study defining efficiency of software testing using applications in table 2 Orange HRM system elements which we investigated on different parametric comparison and most of efficiency parameter satisfied by our framework. The performance testing results our approach depicted in figure 2; in which x-axis describes the elements of selected application and y-axis illustrates the elements performance percentage after testing in cloud environment.

We use the validation model metrics for testing performance which used in exiting literature to support SaaS and TaaS services i.e. Computing Resource Utilization Meter (CRUM), for resources usage monitoring, System Performance Meter (SPM) monitoring the system performance, System Load Meter (SLM), to evaluate system load for network load, and data access load [4]. The results of these performance testing validation in table 3 which describes that our approach feasible for testing activities while using SaaS as TaaS.

4. CONCLUSION

With the advancement in technological industry cloud computing is one of the environment

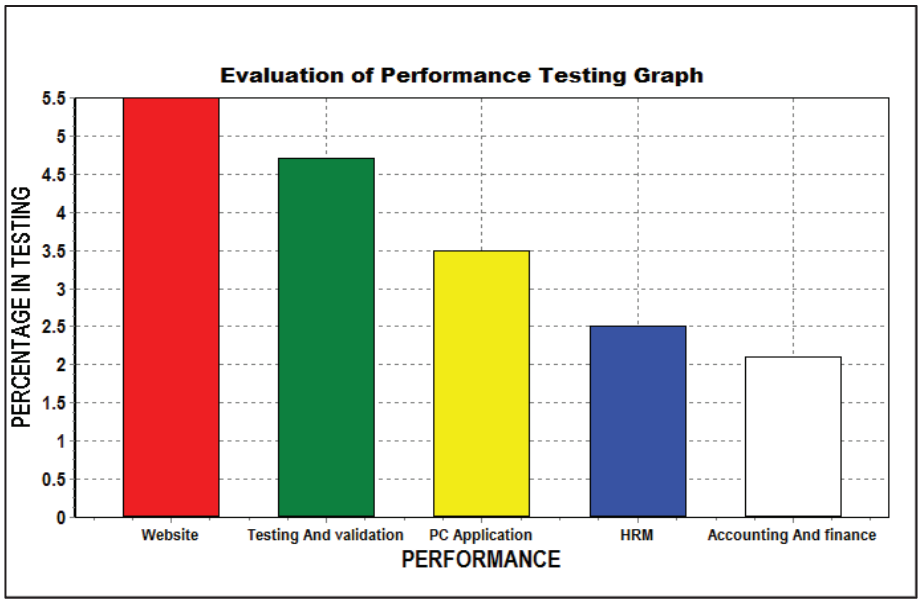

Fig. 2. –Evaluation of Performance Testing using Graph

Table 2. Defining Efficiency of Software Testing Using Applications

✓ = "Exists"			X = "Does not exists"	
	Increased Performance	**Cost Effective**	**Reduce Time**	**Increased Task Resource Management**
Website	✓	✓	✓	X
Testing & Validation	✓	✓	✓	✓
PC Applications	✓	X	✓	✓
HRM	✓	✓	✓	✓
Accounting & Finance	✓	✓	✓	✓

Table 3. Report of Performance Testing Operation

Report					
Test Evaluation model	**No. of user Access**	**Test No.**	**No. of Test Scripts**	**Start Time**	**End Time**
CRUM	600	Test#1	32	18:03:34	19:15:02
SPM	1600	Test#2	32	19:12:03	19:22:12
SLM	2000	Test#3	32	19:33:01	19:32:00

architype in which infrastructure, platform and software are uses as services. Mostly used service model is SaaS for using complete and running application, web services, systems etc. and testing of these SaaS services is the difficult for engineers to test and maintain them with low cost and time. But there have some open issues and challenges in SaaS and TaaS which come across from literature that is lack of resource management and monitoring interfaces. In our study we merge TaaS and SaaS Platform to help quality engineers for automatic test cases production, execution, collection and fault tolerance to reduce load, job scheduling, monitoring and management within limited time and less efforts. The Orange HRM system as case study to empirically investigate our model performance testing to reduce testing time, customer pleasure, avoid misunderstandings, provide easy data flow and less hard work. The results depicted that merging TaaS with SaaS context upsurges the proficiency and efficacy for software testing requests from clients. TaaS switches with SaaS

testing agents for dealing with client's requests and pass to all the layers then saved in repositories. As such, this area has high potential for additional research, tool and technique development to deal with large multi-tenant clients and efficient dynamic provision of fault free services.

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