

THE CONCEPTUAL VIEW OF TESTING AS A SERVICE (TAAS) ON CLOUD

D. Anitha¹, Dr.M.V.Srinath²

¹Research Scholar, Department of Computer Science, STET Women's College, Mannargudi,
Tamil Nadu, India.

²Director, Department of Computer Science, STET Women's College, Mannargudi,
Tamil Nadu, India.

Abstract— Cloud computing leads a chance in contributing a Testing as a Service (TaaS) for cloud, and cloud-based applications. It offers new business challenges, opportunities, and demands in advanced service models, QoS standards, testing techniques, and desires. This paper delivers a conceptual view on testing as a service in a cloud platform. It provides clear conceptual discussions regarding the testing as a service (TaaS), including its objectives, scope, motivations and values, required techniques, distinct features as well as testing environments. It not only provides the classification of diverse types of testing services in TaaS, but also provides the clear comparative study about the conventional software testing service and cloud-based testing as a service.

Index Terms—Cloud computing, Cloud based Testing, Conventional Software Testing Service, Software as a Service (SaaS), Testing as a Service (TaaS), and Testing Services.

1. INTRODUCTION

Cloud computing is shifting the way of management and distribution of computing networks, systems, and software, however it also takes new business challenges and opportunities in software industry and IT industry[1-3]. One of them is software testing. An innovative term, called as testing as a service (TaaS), which is becoming a hot topic in a diverse research communities, and cloud computing and IT businesses. TaaS in a cloud organizations are measured as a new service model and business, in which a TaaS provider assumes software testing project actions and tasks for an under-test web-based software in a cloud organization, and distributes them as a service for clients[4, 5]. Though there are many papers deliberating cloud technologies, architectures, and design, models, and management, cloud testing and TaaS are still new research topics in both software engineering community and cloud computing community. Most of the internet-based applications are stimulated into the cloud world, and many of the SaaS applications and cloud-based systems industrialized, there will be a robust testing service demand in cloud infrastructures and environments[6]. This suggests that many quality assurance managers and test engineers have to comprehend the new issues, challenges, and needs in testing as a service on clouds.

This paper is provide a tutorial on Testing as a Service by wrapping its essential ideas and facilitating in-depth discussion in diverse perspectives. This paper presents and clarifies the testing services in a cloud background, including its objectives, scope, features, distinct requirements, and benefits. Moreover, this paper organizes several testing services for SaaS and cloud based applications, and addresses new challenges, issues, and needs. In

addition, it presents a comparative view among the conventional software testing services and TaaS in a cloud infrastructure.

Many software and IT vendors and businesses like to find out why TaaS is essential, and where and when they requisite TaaS[7]. Here is a list of some chief reasons.

1.1 COST-REDUCTION AND RESOURCE

TaaS in a cloud infrastructure allows SaaS and IT vendors to set up a simulated testing workroom on a public (or private) cloud without obtaining testing resources and computing resources (i.e. test tool certificates). It minimizes the front costs and maximizes the resource utilization and sharing. For a big IT company, the cloud-based TaaS delivers a cost-effective way to sustenance many manufacture lines which need diverse test tools and computing resources.

1.2 SCALABLE TEST ENVIRONMENTS WITH VIRTUALIZATION

Cloud-based TaaS are able to provide a scalable test environment for both the online and SaaS applications due to the elastic nature of clouds through an automatic provision and de-provision. It is based on the physical and virtual computing resources. This feature discourses the strong demand of SaaS scalability measurement and performance/load testing by associating the large-scale test simulation and execution[8].

1.3 ON-DEMAND AUTOMATIC TESTING SERVICE IN 365/7/24

TaaS is capable to offer on-demand automated testing services to answer diverse online test services from SaaS and It vendors at anywhere and anytime[9].

1.4 PAY AS YOU TEST AT ANY TIME

Contrasting conventional software testing services, whereas in TaaS clients and customers are charged for their established services with the help of cost metrics and pre-defined utility model. They will be charged in a pay-as-you-test strategy. This strategy offers more flexibility for TaaS clients to meet service needs and dynamic business[10].

1.5 QUALITY CERTIFICATION BY THIRD PARTIES

Simply leverage accessible cloud system infrastructure to test and calculate system (SaaS/Cloud/Application) scalability and performance.

1.6 MULTI-TENANT BASED TESTING SERVICES

As multi-tenancy is a distinct feature of SaaS applications, it should support multi-tenant based testing services based on the given service level agreements and QoS requirements in performance, functions, and security[11].

The paper is organized as follows: section 2 presents the testing environments and form supporting TaaS. Section 3 discusses about the TaaS community. Section 4 presents the comparative study about the conventional and TaaS services. The paper is concluded in section 5.

2. TESTING ENVIRONMENTS AND FORMS SUPPORTING TAAS

There are three diverse forms of TaaS in a cloud environment. They have different focuses and objectives[12]. They are discussed as follows:

- TaaS for web-based software on clouds – Here, a web based software is positioned on a cloud, and authenticated using the delivered test services which is given by TaaS vendors. The main motivation here is to take the merit of large-scale test simulations and flexible computing resources on a cloud platform.
- TaaS on clouds – Here, a cloud-based applications and SaaS systems are implemented, executed, and authenticated on a cloud for software authentication on a cloud infrastructure or a cloud platform. Different the previous form, TaaS on clouds should address and authenticate the multi-tenancy and scalability of SaaS systems. Usually a SaaS system is implemented based on a specific cloud's skills and its corresponding services, SaaS connectivity protocols and APIs need be authenticated.
- TaaS over clouds – Here, a SaaS applications crossing hybrid clouds are executed and validated with the help of different clouds (such as private clouds, and public clouds). A diverse on-demand test services are provided and delivered by a TaaS vendor in a hybrid cloud infrastructure. A classic SaaS system crossing multiple clouds habitually is structured with components, servers and service software deployed crossing across several clouds. Fig.1 shows the different levels of TaaS.

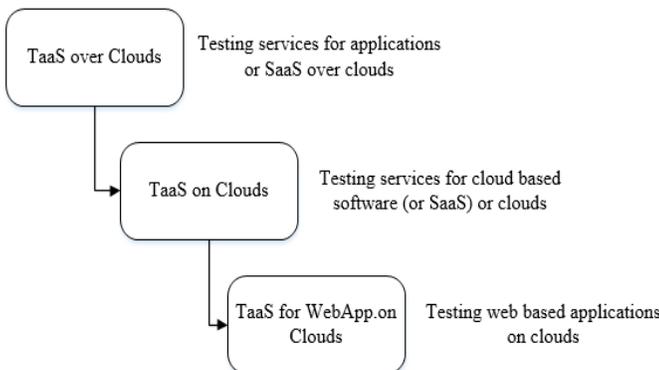


Fig.1 Different Levels of Testing as a Service (TaaS)

There are three types of cloud-based test environments are available which is depicted in fig.2[8].

- Private/public cloud test environment: Vendors organize SaaS applications SaaS in a private (or public) cloud to authorize their quality.
- Cloud-based enterprise test environment: Vendors organize web-based applications in a cloud to authorize their quality in a cloud infrastructure. As shown in Fig. 3(b), this cloud-based enterprise test environment is valuable to test the cloud-based enterprise service programs where
- Hybrid cloud test environment: Vendors organize cloud-based applications on a hybrid cloud infrastructure to validate their quality.

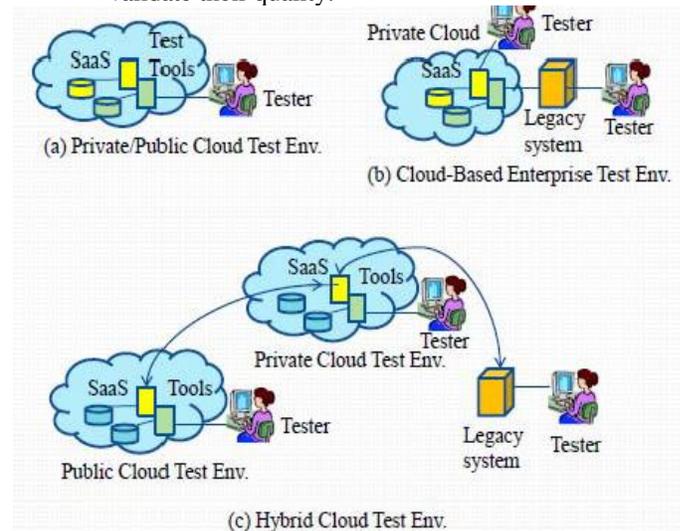


Fig. 2 Different Test Environments[8]

2.1 THE SCOPE AND CLASSIFICATION OF TESTING AS A SERVICE

Fig. 3 depicts the scope of TaaS, which includes the following eight kinds of testing services.

- Scalable test environment service – This permits clients to organize and set up their required virtual test laboratory environment by demanding and selecting diverse computing resources and certified tools for software testing.
- Multi-tenant test modeling and adequacy service – This permits adequate test coverage analysis techniques and test modeling tools to sustenance engineers to conduct SaaS testing with the help of multi-tenanted SaaS requirements insecurity, functions, and performance.
- Digital test management service – It supports test-ware management, test project management, and noticed problem management. Here, a test-ware comprises of test suites with test data, test cases, and scripts, and test results. All these test-wares are accomplished and gathered based on the types of testing. Moreover, they can be downloaded, uploaded, migrated and transferred upon user requests.

- On-demand automated test and control service - This permits on-demand automated control services and test execution based on the requested testing task schedules for a test project.
- Test solution integration and composition service – This delivers the varied systematic test solutions using well-defined test methods, models, and algorithms to accomplish well-known test criteria. For any particular test solution, vendors should deliver solution generation, selection, integration, adoption, and composition services. Here, a test solution refers to test modeling tools, test algorithms and methods, management technology and test-ware generation.
- Test tracking and monitor service – This permits test engineers to monitor and track diverse program behaviors at diverse levels in/on/over clouds through a test process.
- Large-scale test simulation service - This provisions test engineers to set up the required test simulation environment with certain facilitates like tools to fulfill the diverse types of simulation requirements. General types of simulation needs comprises of SaaS/cloud connectivity simulation, communication traffic and load simulation, domain process-based simulation and GUI-based user scenario simulation.
- TaaS contracting and billing service – It provides end users with TaaS service management in contracts, accounts, and billing reports. TaaS vendors are capable to offer customers with selectable testing service contracts based on the pre-defined billing metrics and pricing models.

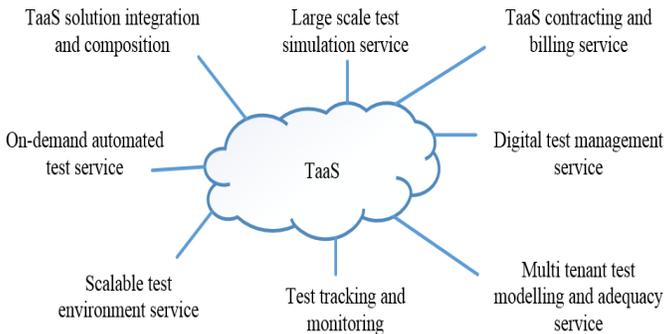


Fig. 3 Scope of Testing as a Service (TaaS)

2.2 New Features in TaaS

Unlike a conventional web-based software testing organization has many unique distance requirements and features. Many of the literatures have discussed a number of new features and requirements in diverse perspectives. Here are some examples:

- In Cloud-based testing environment[7, 11], a diverse test ware and computing resources can be configured, selected, and provisioned (or de-provision) vigorously.
- In SLA-based software testing [8], a well-defined QOS service-level agreements are the important base for testing services.
- In Utility billing and price models [7, 11], the billing approach, pre-defined utility model, and cost metrics are used for the pay-as-you-test approach.

- In On-demand testing service[7, 11], various on-demand service requests will be delivered and process in a testing service SaaS from a TaaS vendor.
- In Large-scale test simulation [7, 11, 13], a large scale test simulation is vital to sustenance system level testing in system performance, scalability, reliability, load, and availability.

Other new characteristics of TaaS are:

- Both testing and computing resources are commodes
- Testing for multi-tendency of SaaS application
- Continuous validation and re-testing
- Testing SaaS is testing SaaS with its databases
- Intelligent on-demand test automation services
- Test solution integration and composition service

3. TAAS COMMUNITY

TaaS refers to offering the static or dynamic on demand testing services in/on/over clouds for the third-party at any time (365/7/24) and anywhere. One of the primary goal is to minimize the IT budget of businesses to effort on their core businesses by subcontract software testing responsibilities to a third party with the help of TaaS service model. TaaS contains the on-demand test execution of distinct suites of test material, usually on an outsourced basis. The implementation can be accomplished either on remotely or client site from the outsourced providers test facilities or lab.

Cloud vendors can set a TaaS community as a cloud to provide various testing services for diverse types of cloud users. There are three categories of TaaS client users. They are: (a) cloud test managers, (b) test engineers or QA engineers, and (c) end users of SaaS.

Each TaaS cloud involves three kinds of vendors.

- Cloud vendors provide the essential networks, such as storage resources and computing, and internet infrastructures.
- Test solution vendors offer diverse test tools, process management solutions and test project.
- Test-ware vendors use free-lance, in-house, or third party engineers to offer test-ware design and generation service for a contracted test project, including test cases, documents and test scripts.
- Testing service vendors offer, manage, and control TaaS platforms, infrastructures, and deliver testing services with the help of provided resources, test-wares, and test tools from other vendors.

Vendors may set up three kinds of TaaS clouds.

- Private TaaS cloud, which offers and deliver diverse devoted testing services on a private cloud to restricted users for private enterprises and businesses,
- Public TaaS cloud, which offers and delivers various testing services on a public cloud to public users for quality engineering education and software testing, certification and training purposes.
- Community TaaS cloud - which offers and delivers numerous testing services on a community cloud. A common example will be a research TaaS community cloud

subsidiary for TaaS research, result authentication and case trainings.

Table 1 provides a relative view from service perceptions between conventional software testing services and testing as a service on clouds.

4. CONVENTIONAL TESTING SERVICE VS TAAS

Table 1 Comparison between Conventional Software Testing Services and TaaS services

Service types	Conventional software testing services	TaaS services
Primary Goals	<ul style="list-style-type: none"> Labor intensive testing services to decrease engineering costs. Validate software quality based on the given requirements 	<ul style="list-style-type: none"> Solution-based services to decrease resource and testing costs for test projects Guarantee SaaS quality against predictable system function requirements and SLAs
QoS requirement modeling and specification service	<ul style="list-style-type: none"> Apply ad-hoc or standards, enterprise-oriented QoS requirements, and specifications. Accomplish ad-hoc test modeling analysis 	<ul style="list-style-type: none"> Exhibiting QoS requirement with selectable test models with QoS modeling services
Testing Focuses	<ul style="list-style-type: none"> System functions and system QoS attributes, such as reliability, performances, availability, security, vertical scalability, and so on. 	<ul style="list-style-type: none"> SaaS service functions, and special features, such as multi-tenancy, configurability and customization. SaaS QoS attributes, such as scalability and reliability. SaaS connectivity, interoperability and portability.
Test process support	<ul style="list-style-type: none"> Physically perform a pre-selected ad-hoc or enterprise oriented test process with a designated test process tool 	<ul style="list-style-type: none"> Select, apply, and perform a well-defined test process obtainable by a TaaS vendor and maintained in a tool
Test modeling	<ul style="list-style-type: none"> Perform ad-hoc test modeling and analysis 	<ul style="list-style-type: none"> Perform diverse test modeling & analysis using tools
Service delivery	<ul style="list-style-type: none"> Manual service delivery following a pre-defined contract 	<ul style="list-style-type: none"> On-demand dynamic test service delivery in 356/7/24
Service business	<ul style="list-style-type: none"> A project-based business model with testing contracts 	<ul style="list-style-type: none"> A service-based transaction model based on a service-level-agreement and defined cost model
Testing Execution	<ul style="list-style-type: none"> Offline testing in a test lab before a product delivery 	<ul style="list-style-type: none"> Offline testing in a private cloud-based test environment. On-demand test execution in a cloud-based virtual test environment. Continuous testing for SaaS in/on/over clouds.
Test environment	<ul style="list-style-type: none"> Manually configure and set-up a test laboratory and environment with physical computing resources 	<ul style="list-style-type: none"> Systematic design and set-up scalable test environment based on physical and virtual computing resources. Dynamic provision and de-provision of computing resources.
Test edition and generation	<ul style="list-style-type: none"> Manual and semi-automatic test edition and generation using licensed or in-house tools 	<ul style="list-style-type: none"> Semi-automatic test edition and generation using selective test generation tools based on desirable test models
Test composition and integration	<ul style="list-style-type: none"> Ad-hoc test editing, integration, and composition using limited tools 	<ul style="list-style-type: none"> Semi-automatic test edition, integration, and composition using selective tools
Test Tool	<ul style="list-style-type: none"> Manual test tool configuration and deployment of limited licenses 	<ul style="list-style-type: none"> On-demand selection, configuration and deployment of highly shared tools provided by TaaS vendors

Test ware	<ul style="list-style-type: none"> Manual organization of test scripts and test suites (test cases/data) following enterprise-based templates using a selected test tool 	<ul style="list-style-type: none"> Systematical test-ware service management for test suites (test cases/data) with the help of selective tools Test suite migration, download and upload services
Testing Techniques	<ul style="list-style-type: none"> Apply selected well-known white-box and black-box testing techniques at the component level (or unit level) and the system level 	<ul style="list-style-type: none"> All existing testing techniques for software Required innovative continuous testing techniques New testing solutions to deal with SaaS multi-tenancy and elasticity
Test service cost	<ul style="list-style-type: none"> Calculating hardware, tools, and engineering costs 	<ul style="list-style-type: none"> Based on a pre-defined service-level-agreement (SLA) Pay-as-you-test service costs
Test simulation	<ul style="list-style-type: none"> Generate and perform limited test simulation in a prefixed test environment using selected simulation tools 	<ul style="list-style-type: none"> Perform and apply customizable and configurable largescale data load, traffic load, and user accesses with test simulation services

Some of the technical challenges are:

1. Continuous validation and regression testing
2. Testing solution integration and composition
3. Lack of connectivity standards
4. Lack of test tool standards and
5. Lack of well-defined cost models and billing metrics
- 6.

5. CONCLUSION

Nowadays, TaaS is becoming a latest research issue in both software engineering and cloud computing research communities. Due to the development of cloud technology and testing as services, further research results are required to address the open challenges and issues on TaaS techniques, infrastructures, and automation resolutions. Hence, more advanced testing methods and solutions, and QoS standards are required to support the on-demand testing services in a scalable cloud infrastructure. This paper offers essential tutorial concepts on TaaS definitions, motivations, scope, and benefits. In addition, it discusses in details about TaaS requirements, and challenges. Additionally, it also highlights the major differences between conventional software testing and cloud-based TaaS.

REFERENCES

- [1] M. Armbrust, A. Fox, R. Griffith, A. D. Joseph, R. Katz, A. Konwinski, *et al.*, "A view of cloud computing," *Communications of the ACM*, vol. 53, pp. 50-58, 2010.
- [2] J. Gao, X. Bai, W.-T. Tsai, and T. Uehara, "Testing as a service (taas) on clouds," in *2013 IEEE 7th International Symposium on Service Oriented System Engineering (SOSE)*, , 2013, pp. 212-223.
- [3] S. Sharma, "Evolution of as-a-Service Era in Cloud," *arXiv preprint arXiv:1507.00939*, 2015.
- [4] L. Yu, W.-T. Tsai, X. Chen, L. Liu, Y. Zhao, L. Tang, *et al.*, "Testing as a Service over Cloud," in *2010 Fifth IEEE International Symposium on Service Oriented System Engineering (SOSE)*, 2010, pp. 181-188.
- [5] S. N. Pardeshi and V. Choure, "Testing as a Service on Cloud: A Review," *International Journal on Recent and Innovation Trends in Computing and Communication*, vol. 2, pp. 188-193, 2014.
- [6] A. Sathe and D. R. Kulkarni, "Study of Testing as a Service (TaaS)–Cost Effective Framework for TaaS in Cloud Environment," *International Journal of Application or Innovation in Engineering and Management (IJAIEM)*, vol. 2, 2013.
- [7] J. Gao, K. Manjula, P. Roopa, E. Sumalatha, X. Bai, W.-T. Tsai, *et al.*, "A cloud-based TaaS infrastructure with tools for SaaS validation, performance and scalability evaluation," in *2012 IEEE 4th International Conference on Cloud Computing Technology and Science (CloudCom)*, 2012, pp. 464-471.
- [8] J. Gao, X. Bai, and W.-T. Tsai, "Cloud testing-issues, challenges, needs and practice," *Software Engineering: An International Journal*, vol. 1, pp. 9-23, 2011.
- [9] T. Parveen and S. Tilley, "When to migrate software testing to the cloud?," in *2010 Third International Conference on Software Testing, Verification, and Validation Workshops (ICSTW)*, 2010, pp. 424-427.
- [10] R. L. Krutz and R. D. Vines, *Cloud security: A comprehensive guide to secure cloud computing*: Wiley Publishing, 2010.
- [11] X. Bai, M. Li, B. Chen, W.-T. Tsai, and J. Gao, "Cloud testing tools," in *2011 IEEE 6th International Symposium on Service Oriented System Engineering (SOSE)*, 2011, pp. 1-12.
- [12] W. T. Tsai, G. Qi, L. Yu, and J. Gao, "TaaS (testing-as-a-service) design for combinatorial testing," in *2014 Eighth International Conference on Software Security and Reliability (SERE)*, 2014, pp. 127-136.
- [13] J. Gao, P. Pattabhiraman, X. Bai, and W.-T. Tsai, "SaaS performance and scalability evaluation in clouds," in *2011 IEEE 6th International Symposium on Service Oriented System Engineering (SOSE)*, 2011, pp. 61-71.