

Viewpoints

Cloud-Based Mobile Testing as a Service

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With the rapid advance of mobile computing, cloud computing and wireless network, there is a significant increase of mobile subscriptions. This brings new business requirements and demands in mobile testing service, and causes new issues and challenges. In this paper, informative discussions about cloud-based mobile testing-as-a-service (mobile TaaS) are offered, including the essential concepts, focuses, test process, and the expected testing infrastructures. Moreover, the paper presents a comparison among cloud-based mobile TaaS approaches and several best practices in industry are discussed. Furthermore, the primary issues, challenges, and needs are analyzed.

Keywords: Mobile testing as a service; cloud-based infrastructure as a service; mobile application testing.

1. Introduction

With the rapid advance of mobile computing technology and wireless networking, there is a significant increase in mobile subscriptions. This brings new business requirements and demands in mobile software testing, and causes new issues and challenges. Testing mobile applications on diverse mobile browsers and platforms on

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different devices become very difficult and costly due to large-scale mobile use access, constant updates of mobile devices and mobile technologies, and fast upgrading of mobile application services [1–12]. According to [1, 2], TaaS in a cloud infrastructure is a new business and service model. A TaaS provider undertakes software testing project activities and tasks for under-test web-based software and systems in a cloud infrastructure, and delivers them as a service for customers. Therefore, cloud-based mobile TaaS is needed to solve major issues in mobile application testing. These issues include: (a) high costs on mobile test infrastructures due to frequent changes and upgrades on mobile applications; (b) testing complexity of complex mobile user interfaces; (c) large-scale mobile test services, test simulations, and virtualizations; and (d) multi-tenancy of mobile applications. This paper is written to offer informative viewpoints on cloud-based mobile testing-as-a-service (mobile TaaS) from service providers. This paper covers the essential concepts, testing process, the expected testing approaches and infrastructure, as well as the primary issues, challenges and needs.

2. Understanding Cloud-Based Mobile Testing as a Service

According to [4], mobile TaaS provides on-demand testing services for mobile applications and/or SaaS to support software validation and quality engineering processes by leveraging a cloud-based scalable mobile testing environment to assure pre-defined given QoS requirements and service-level-agreements (SLAs). Cloud-based mobile TaaS offers a new business and service model for diverse mobile software validation using the pay-as-you-test model to achieve cost-sharing and cost-reduction in mobile computing resources, networks, cloud computing and storage infrastructures.

Compared to conventional mobile testing, the test process of cloud-based mobile TaaS primarily focuses on typical features such as tenant-based testing and

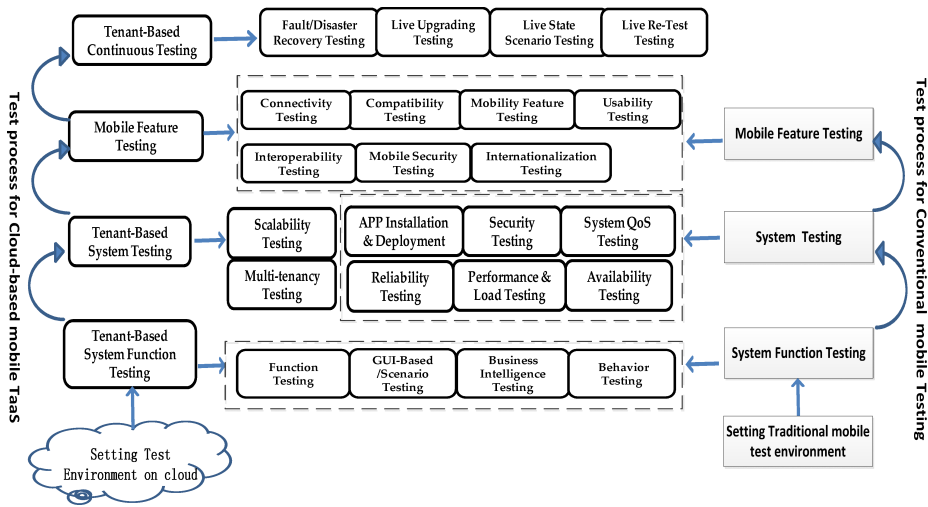


Fig. 1. A comparison of test process for cloud-based mobile TaaS and traditional mobile testing.

scalability testing. Figure 1 shows a test process (function testing) for mobile TaaS and traditional mobile testing. The left-side process represents cloud-based mobile TaaS, and the right-side process shows traditional testing. Please note the testing activities in the dashed frame are shared by both sides. The testing process is shown as follows.

Step 1. Setting test environment on cloud, including test control and run, tracking and monitor, interactions with TaaS server as well as its underlying mobile emulation cloud (or device cloud);

Step 2. Tenant-based system function testing, includes diverse tenant-based service functions and features;

Step 3. Tenant-based system testing, checks multi-tenancy, QoS, scalability, etc.;

Step 4. Mobile feature testing, targets mobility feature testing, usability testing, compatibility testing, etc.;

Step 5. Tenant-based continuous testing, considers how to keep continuous validation for mobile system, including recovery testing, live upgrading testing, regression testing, etc.

3. Approaches and Infrastructure for Cloud-Based Mobile TaaS

Due to the new features in mobile TaaS on cloud, conventional testing approaches encountered many difficulties such as large-scale testing services and on-demand testing needs. Thus, new approaches and infrastructure are needed to address the special features. This section presents some typical current solutions and makes a comparison among different approaches.

- ***Emulation-based or simulation-based mobile testing infrastructure on clouds*** — In this form, mobile-based applications or SaaS instances are validated using large-scale mobile emulators or simulators on cloud. This mobile cloud needs to support configuring diverse mobile emulators with different configurations. In addition, this cloud is required to have several key components, such as mobile emulation controller and test connection manager.
- ***Crowd-based mobile testing infrastructure on clouds*** — In this form, mobile application servers on a cloud are validated using ad-hoc mobile testing environment and TaaS infrastructure based on crowd sourcing. This approach does not need costs of mobile devices. In addition, it is easy to support large-scale compatibility testing and usability tests crossing diverse mobile devices.
- ***Device cloud-based mobile testing infrastructure on clouds*** — In this form, real mobile devices are purchased, deployed, and used to validate mobile-based software applications (including mobile APPs and mobile Web applications) and mobile SaaS. Unlike other mobile devices, they are structured, connected, configured, and set up to meet mobile testing service needs according to on-demand test service requirements.

Currently, there are more and more industry practices on how to provide testing services for mobile applications based on (mobile) cloud. For instance, TestDroid by Bitbar offers on-demand mobile testing services on thousands of real Android and iOS devices (<http://testdroid.com/>) based on self-developed cloud infrastructure. Keynote by dynatrace addresses cloud-based testing, monitoring, and analytics solutions optimize quality and performance (<http://www.keynote.com/solutions>). Company uTest utilizes crowdsourcing as a critical complement for testing web and mobile app in the lab (<http://www.utest.com/company>). Recently in 2015, a company *Testin* (<http://mtestin.com/>) released the crowd sourcing testing service platform in order to meet the demand of large-scale *testing in cloud*. *Perfectomobile* provides MobileCloud Interactive, MobileCloud Automation, and MobileCloud Monitoring (<http://www.perfectomobile.com/>). Table 1 lists the current major players in cloud-based mobile TaaS.

To provide evidence of success in using cloud-based mobile TaaS, we discuss two industrial cases of best practices. Humana, a Fortune-100 health and well-being company with more than 40,000 associates provides consumers and businesses with access to information via mobile channels across their various health care operations in all 50 U.S. states. Humana required a solution for testing mobile apps and websites, to ensure their members continued reliable access to healthcare information. With the support of DeviceAnywhere mobile testing platform from *Keynote*, Humana has set up a local dedicated testing environment to cover all of their mobile channels. With this test environment the healthcare provider can run manual and automated tests on 50 live devices, including iOS, Android, and Blackberry platforms. In the past Thanksgiving, some businesses performed very well with their mobile apps. Internet Retailer cited Catchpoint data that pointed to the five native mobile apps that provided users with excellent buying experiences on Black Friday. At No. 1 is Foot Locker with search times as fast as 0.133 seconds with performance testing from Perfecto (<http://blog.perfectomobile.com/2015/12/03/>).

Table 1. Comparisons of several major players in mobile TaaS practices.

Major Players	Testin	Yiceyun	PerfectoMobile	uTest	TestDroid
Approach	crowdsourcing	crowdsourcing	emulation cloud	crowdsourcing	emulation cloud
Real devices	yes, 4000+	yes, 200+	yes, 200+	No	yes, 400+
AutoTest	no	no	yes	no	yes
Deploy Method	central control plus user device	User device	continuous Quality Lab	user device	centers in US and Europe
OS Type	iOS, Android	Android	iOS, Android	iOS, Android	iOS, Android
Testing	install/uninstall, compatibility, function, performance	adaption, traverse, performance	remote, performance, monitoring	global testing community	function, performance
Focuses					

4. Issues, Challenges, and Needs

This section summarized several current issues and needs which existed in testing criteria and standards, infrastructures and testing models.

Issue #1: *Lack of well-defined infrastructure and approaches on cloud which allow both mobile application vendors and users to access mobile TaaS services.*

Need #1: *More study and research results on cloud-based mobile TaaS infrastructure and mobile testing environment supporting on-demand elastic mobile testing resources and offering unified mobile test automation services.* Since mobile scalability is one important QoS evaluation parameter, engineers must validate it using both emulation-based and device-based testing approaches. To support this, engineers need to perform an elastic cloud-based mobile test infrastructure based on a remote mobile device cloud and mobile virtualization. Hence, a desirable mobile TaaS infrastructure is needed to support auto-provision of mobile testing resources with elastic scalability.

Issue #2: *Lack of standards in mobile test environment, billing charges, tools, and test automation for mobile testing services on cloud.*

Need #2: *Developing well-defined standards for mobile TaaS services.* Several types of standards are needed. The first is a standard cloud-based mobile test environment which can be easily defined, configured, deployed, and executed. And the other refers to standard testing service protocols and APIs supporting test services.

Issue #3: *There is a lack of well-defined test models and coverage criteria to address distinct needs in cloud-based mobile testing.*

Need #3: *Well-defined test models and criteria to address the special mobile app features.* Several recent publications address this demand. For example, a semantic tree model in [5] is used to present diverse mobile testing environments of mobile apps. The authors in [6] introduce an approach to focus on testing location-based function services using a dynamic graph-based model. However, there is still a demand for more test models and coverage criteria for mobility testing and usability testing.

5. Conclusions

Cloud-based mobile TaaS offers four major advantages. These include: (a) offering large-scale mobile testing anytime and anywhere in 7/24/365; (b) cost reduction by sharing mobile computing resources; (c) supporting on-demand mobile testing services with elastic mobile testing resources; and (d) providing elastic scalable mobile test automation. With the fast increase of mobile app deployments on devices, engineers need more adequate validation methods and test automation tools to cope with the issues discussed and challenges in mobile application testing.

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