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Testing Approaches for Mobile Applications using M-TaaS

Sehba Shahabuddin Siddiqui, Varsha Nagpurkar

Abstract— Due to high popularization and rapid development of cloud services along with advancement in mobile computing technology and wireless services, a new software testing service has come up called testing as a service (TaaS). Usage of wide scale mobile devices with heterogeneous environment and platform, testing as a service utilizes cloud infrastructure to provide on demand testing services for customers all time. With increase in utility of mobile applications (apps) due to ease of internet access along with rise in demand of critical applications like mobile banking, mobile social alerts for reporting accidents, apps for monitoring traffic etc. testing of mobile apps plays a vital role. M-TaaS over cloud provides a new business standard for diversified mobile applications software validation service employing pay-as-you-test model in order to attain cost sharing and reduction in mobile computing resources, networks, cloud computing and storage. Paper addresses different testing approaches for mobile applications like emulation based testing, device based testing, cloud testing, crowd-based testing in order to cope up with frequent up gradation of mobile devices and technologies, hence developers need a reusable and cost-effective environment for validating mobile applications and flexible infrastructure for supporting large scale test automation.

Index Terms— mobile testing; mobile app testing;mobile TaaS; TaaS.

I. INTRODUCTION

There is an explosive demand for mobile devices primarily in form of smart phones, tablets etc. Native and Web applications for these devices lead to demand for more and better mobile application testing. Mobile development is characterized by diverse applications with different quality requirements. Online application stores, Apple App Store and Google Play, offer market-oriented apps—mobile games, utilities, navigators, social networks, and clients for web resources [1]. In last decade, mobile phones have emerged into powerful, dynamic, connected and smart devices that are able to deliver all types of services instantly [2]. New business requisites and demand in mobile software testing, causes new issues and challenges for mobile testing service automation [3]. According to a study report of ABI Research conducted on October 22 2012, income from mobile application testing tools would surpass $200 million due to test automation demand for mobile apps. Report estimates that growth of test automation would push revenue close to $800 million by end of 2017 [4].

Paper discusses mobile TaaS infrastructure which aims to supports cloud-based mobile application testing using distinct approaches; (a) cloud based testing on mobile device test cloud; (b) emulation-based testing on an emulation cloud. Its major purpose is to solve serious issues in mobile application testing as follows, (a) high costs in current mobile testing practice and environments, (b) shortage of testing support and tools for mobile scalability testing; (c) advanced mobile testing complexity and harness due to high variety of mobile devices, platforms, browsers, and environment.

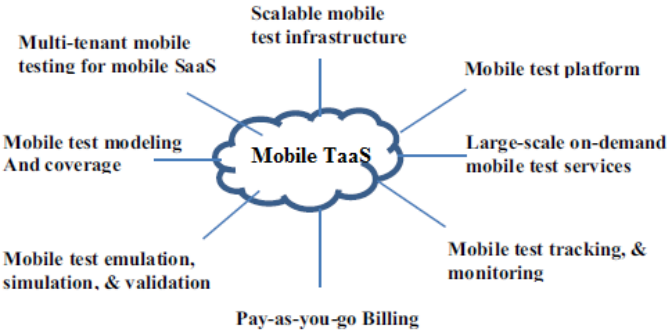

Fig.1. Scope of mobile TaaS.

A. Types of testing activities in M-TaaS:

Mobile testing-as-a-service (M-TaaS) includes eight types of testing activities, (a)*Scalable mobile test infrastructure* that offers on how to build elastic, scalable cloud-based infrastructure supporting automatic provision on mobile resources, mobile devices, emulators, platform browsers; (b) *Mobile test platform,* testing platform technology enables to construct and set-up a mobile testing environment, there by meeting diverse requisites on mobile devices, including mobile platforms, browsers, and connectivity; (c) *Mobile test tracking and monitoring,* refers to tracking and monitoring techniques, solutions for mobile test operations at different levels for mobile apps and mobile web applications. d) *Large-scale on-demand mobile test services,* for pointing servicing techniques responding to on-demand mobile test in mobile testing environments, test-ware, test execution and control; (e) *Mobile test emulation, simulation and validation,* studying and applying distinct mobile testing approaches; (f) *Mobile test modelling and coverage,* includes activities that check mobile usability, user interfaces, language-based contents, rich mobile user operations and experience; (g) *Multi-tenant mobile testing* for mobile software as a service (SaaS), testing of multi-tenanted functions, behaviours, quality of service(QoS) requirements for SaaS multi-tenancy;

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(h) *Pay-as-you-go* utility billing refers to the service business model in which mobile testing clients would utilize pay-as-you-go model for mobile computing testing resources, as well as services.

B. Significance of mobile testing as a service:

The urge of testing as a service (TaaS) is recognized by [5] [6], addresses primary objectives of M-TaaS and its significance:

1. Cost reduction by leveraging cloud computing resources and mobile device sharing: reducing usage of mobile device resources by utilizing cloud infrastructure, sharing of mobile devices and resources, utilizing device-rental service model.

2. Frequent up gradation of mobile platforms and technologies: providing non-affordable costs for many sellers to test mobile and web applications to keep mobile technology for updates on devices, platforms, API's, app service functions, service plans.

3. High mobile test complexity: numerous factors subscribe to high mobile test complexity. This includes: (a) diversity in mobile devices, operating systems, browsers;(b) heterogeneous mobile technologies, various native APIs; (c) mobile gestures; (d) multi-model mobile input channels; (e) limited display screens;(f) rich media support;(g) internationalization in mobile contents.

4. Mobile scalability of SaaS and applications: scalability feature requires engineers to pay attention to mobile scalability validation in various aspects: (a) scalable volumes of mobile user requests; (b) scalable mobile connections; (c) scalable mobile test simulation and traffic loads.

5. Mobile usability and internationalization: unique feature in mobile testing such as validating mobility functional features and behaviours in mobile application systems.

6. Testing multi-tenancy of mobile SaaS: It addresses the need to perform validation for multi-tenant functions and behaviour, QoS requirements, mobile data, security features, user interfaces.

C. Cloud based mobile testing approaches and environment:

In Fig. 3 there are three different forms of mobile testing approaches and supporting environment for mobile and web applications on mobile devices.

1. Emulation-based mobile testing environment– Mobile-based SaaS instances on a cloud are validated using large-scale mobile emulators over cloud. Testing is cheaper as no real mobile devices are needed. Limitations in testing are native device-based functions and behaviours.

2. Simulation-based mobile testing environment on clouds – In this form of testing, mobile application servers (or mobile SaaS instances) over a cloud are validated using mobile simulators. This approach does not require real mobile devices. Simulation-based approach over cloud has its advantage on simulating mobile behaviors of different mobile devices.

3. Device-based mobile testing environment on clouds - Real mobile devices are bought, deployed, used to validate mobile-based software 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.

II. MOBILE TAAS CLOUD INFRASTRUCTURE

As shown in Fig.4 infrastructure includes three parts and frameworks listed below:

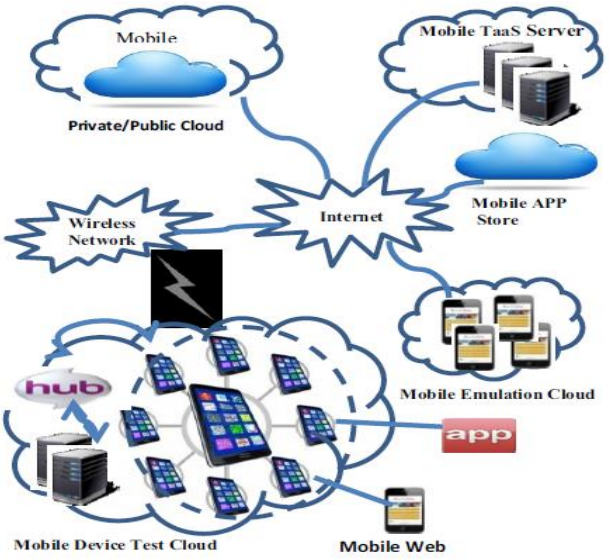

Fig.2. A mobile TaaS Cloud Infrastructure.

1 - ***A mobile device test cloud*** is structured and connects a large number of mobile devices with diversity.

2 - A mobile emulation test cloud, supports elastic large-scale mobile emulation services based on-demand requests.

3 - A mobile TaaS server, supports various testing services for diverse clients in test project and process management, test automation tracking and control, billing and reporting.

Framework 1 – Mobile test connectivity framework provides base to support diverse mobile connectivity.

Framework 2 - Mobile web test framework provides a common-ware and library to support mobile web application testing and automation on mobile devices.

Framework 3 – Mobile app test framework provides common-ware and library to support mobile app testing and automation on mobile devices.

III. MOBILE APPLICATION TESTING

Most of research work on mobile application testing has aimed for solutions to specific technical problems in following areas: (a) white-box and unit testing of mobile apps; (b) black-box and GUI testing of mobile apps; (c) validation of mobile app QoS requirements;(d) wireless network testing;(e) mobile usability testing; and (f) mobile test automation frameworks.

A. Mobile applications and requirements:

Mobile Testing is defined as, "testing native and web applications on mobile devices with well-defined software testing methods and tools to ensure quality in function, behaviour, performance, quality of service, along with numerous features, such as mobility, usability,

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Interoperation ability, connectivity, security, privacy"[7]. Mobile app testing is similar to website testing as both perform validation in distinct environments [8].

Mobile development has a set of distinguish attributing and specific challenges as follows: supporting heterogeneous hardware and software platforms, work efficiently with various sensors, interconnection with various applications, high requirements for users experience of quality user interface, existence of web mobile and hybrid applications that integrate all of these challenges to web development [9].Mobile TaaS over clouds provides a new business model for diverse mobile software validation services using pay-for-what-you-use model to achieve cost sharing and reduction in leveraging mobile computing resources, communication using different network, screen size, memory, processing capacity, and operating system [10].

B. Testing objectives and activities:

In accordance to requisites, mobile application testing targets to focus on following activities to be performed:

Functionality and behavioural testing—activities that perform validation of service functions, mobile web API's, external system behaviour, system-based intelligence, and user interface (UI).

Quality of service (QoS) testing—performs evaluation of system load, performance, reliability, scalability, and throughput.

Interoperability testing—involves activities that check systems compatibility across different devices, platforms, browsers, and wireless network.

Utilization and internationalization testing— It evaluates UI content and alerts, user operation flows and scenarios, swarming media, and gesture interaction assistance.

Security and privacy testing—activities that check user authentication, device and session security, system/network penetration, peer-to-peer (P2P) mobile communication security, end-to-end transaction security, and user privacy.

Mobility testing—validation of location-based function, user profile, system data, and user data.

Compatibility and network connection testing—activities that assess mobile browser and platform compatibility and diverse wireless network connectivity; and

Multi tenancy testing—activities that validate tenant based function, system behaviour, system data, and UI.

Table I shows five popular mobile apps selected to test the approaches in order for executing and designing test cases [2]. They were selected from Google play store [11].

TABLE I MOBILE APPLICATIONS SELECTED TO TEST

Mobile App	Category	Dependence (any other android app)
Duolingo	Education	No
Pou	Game	No
Easy Taxi	Transportation	Yes
Instagram	Social	No
Viber	Communication	No

TABLE II MOBILE APPLICATION TESTING APPROACHES

Testing		Emulation based testing	Device based testing	Cloud Testing
Function and behavior	Functional Features	Single emulator or simulator based	Device-based single client	Large-Scale device-based testing
	Mobile User Operations	Yes	Yes	Yes
	Mobile Gestures	Limited	Yes	Yes
Usability	Mobile User operations	High cost and Manual	High Cost and Manual	Automation and enabled
Interoperability	Cross Devices	No	No	Yes
	Cross Platforms	No	Yes	Yes
	Cross Browsers	Yes	Yes	Yes
	Cross networks	LIMITED	Limited	Yes
Multitenancy	Tenant based functions and behaviour	Yes	Yes	Yes
	Tenant based QOS	Limited Scales	Limited Scales	Limited Scales
	Tenant based interfaces	Yes	Yes	Yes
Quality of Service	Load Testing	Limited Scale	Limited Scale	Large Scale
	Performance Testing	Function Based	Single Client	Large Scale
	Availability	Single Clients	Single Clients	Large Scale

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	Scalability	No	No	Yes
Security and Privacy	User security and privacy	Limited	Limited	Large Scale
	Communication Security	No	Yes	Yes
	Transaction Security	Yes	Yes	Yes
	Session security	Yes	Yes	Yes
	Server Security	Limited	Yes	Yes
Mobility	Location- based functions and behaviours	Based on simulated location	Preconfigured Location	Based on Configured mobile location
	Location-based user data and profile	Simulated user profile and data	Single user profile and data	Large-scale user profile and data

IV. ISSUES, CHALLENGES AND NEEDS

In spite of growing demand in the stream of mobile app testing, it faces numerous issues, challenges and needs that are need to be resolved still. Mobile testing environments requires high cost and level of complexity. Setting up a mobile test environment for multiple apps on each mobile platform for a range of devices is tedious, time-consuming, expensive, and frequent upgrades in both device and platform spaces only exacerbate this challenge. Automated mobile app testing raises two further issues: lack of standardization in mobile test infrastructure, scripting languages, and connectivity protocol between mobile test tools and platforms; and lack of a unified test automation infrastructure and solutions that validates cross platforms and browsers on most mobile devices.

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