Testing Software Services in Cloud Ecosystems

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ABSTRACT

Testing in the Cloud is far more challenging than testing individual software services. A multitude of factors affect testing, including variations across platforms and infrastructure. Architectural issues include differences between private, public Clouds, multi-Clouds and Cloud-bursting. Platform issues include cross-vendor incompatibility, and diverse locales of service deployment and consumption. Software issues include integration with third-party services, the desire to validate competing service offerings to similar standards and need to re-validate services at different stages of service lifecycle. A complete approach to testing whole Cloud ecosystems should involve all relevant stakeholders, such as service provider, consumer and broker. When testing Clouds, the methodologies used should not hinder the advantages Cloud usage brings to the users or programmers and more importantly be simple and cost effective. However, these testing methodologies differ according to the various kinds of Cloud ecosystems and the different user perspectives of the actors involved such as the end-user, the infrastructures, or the different software (i.e. web services). This paper also studies the state-of-the-art in Cloud testing where most research focuses predominantly on web services, functional testing and quality-of-service, usually being considered separately. The authors suggest a framework, Quality-as-a-Service (QaaS) which integrates quality issues such as functional behaviour and performance monitoring with lifecycle governance and security of the service. This paper maps out the themes in the contemporary research literature and links them with the service lifecycle process for validating future Cloud services. Along the way, the authors identify important research questions that the future Cloud service testing agenda should seek to address.

KEYWORDS:

1. INTRODUCTION

Cloud computing is regarded as a new software delivery paradigm and a 5th utility service after water, electricity, gas and telephony (Buyya et al., 2008). Businesses are shifting their technologies to the Cloud in order to save on the costs of infrastructure, maintenance and personnel. However there are various risks associated with using the Cloud and new research is turning to building trust and security standards in order for the customers to use the Cloud with greater confidence (Djemame et al., 1983; Khan et al., 2012; Kiran et al., 2011). Testing becomes an essential part of these standards. Software testing is challenging and expensive requiring time and resources to scrutinize the application’s reliability, functionality and performance. Testing for the Cloud should, in essence, be simple and cost effective; and go beyond the traditional kind of functional and non-functional testing practiced by developers. This is because there is still a need to build trust within the community of
Cloud users, and the need for repeated revalidation of the same software, as it is extended, customized or migrated from one platform to another. The specific testing approaches used differ depending on the various kinds of Cloud ecosystem, which vary according to infrastructure, platform and software architecture and the different stakeholder roles involved. Testing should cover the functional and non-functional aspects of the services. In this paper, various testing issues are discussed in the context of future Cloud ecosystems, which will require a spread of testing methods to validate services at the different interaction points between the stakeholders. The paper also surveys the current state-of-the-art in Cloud testing, identifying the gaps between this and the needs that any future complete Cloud testing methodology should satisfy.

Figures 1 and 2 describe various testing dimensions across Cloud platforms. Depending on the different kinds of platforms, depicting the Cloud environment being used, testing issues vary across these. Examples of these issues include functional testing methods, penetration testing or multi-tenancy testing. These depend on the scenario to show which ones would be relevant to the Cloud ecosystems being used. For instance security testing may have a greater influence in multi-cloud environments rather than private Cloud environments. Besides the environments, Clouds exist in three forms depending on the functionality being offered,

- **SaaS (Software as a Service):** Uses the Web to deliver third-party applications to Clients. For example: Gmail.
- **PaaS (Platform as a Service):** provides framework to build applications on top as well. It provides the computer infrastructures, hardware and highly scalable. Example: GoogleAppEngine, Heroku.
- **IaaS (Infrastructure as a Service)** third party allows you to install a virtual server on their IT infrastructure.

Testing SOA applications, where most literature exists, focuses on the SaaS functionality of Clouds. Further work for the other two functionalities may need to include a collection of testing issues as shown in Figure 3. These are discussed below in this section with an extensive discussion on related issues of testing with Cloud-related aspects, highlighting, functional, non-functional, service oriented architectures and specific Cloud issues.

This paper aims to review and assess the current body of knowledge related to Cloud testing, identifying new research directions. The paper is organized into six sections. Following the introduction, section 2 describes the background and the current research trends in the field of Cloud computing testing. The section also discusses in detail the testing scopes and tools presently available, presenting techniques for functional and non-functional testing requirements. Section 3 describes the stakeholders involved and how the stages in the different Cloud ecosystems can be tested. Section 4 presents the future research directions that testing should have in Cloud ecosystems towards Quality-as-a-service, with the methodology presented in Section 5. Finally, Section 6 summarises the argument with the problems which may still persist on a larger context and should be considered in future research issues.

### 2. BACKGROUND

#### 2.1. Current Research Trends

In order to review the vast literature in Cloud testing, various resources were reviewed to help classify the publication works according to the sub categories in which most work has been done. Various
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*International Journal of E-Services and Mobile Applications* (pp. 1-17).
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