

Adaptive Web Services Monitoring in Cloud Environments

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ABSTRACT

Cloud computing environments provide flexible infrastructures for third-party management of organizations' information technology (IT) assets. With web services being a standard for realizing web-based business capabilities, the emergence of cloud computing will bring new challenges to different web service activities. In this paper, the authors propose an agent-based framework that employs a team of management and monitoring agents on different scopes to provide effective service management in a cloud environment. To tackle the dynamism in service operations, an adaptive monitoring algorithm is proposed. The algorithm is inspired by the congestion control approach from the TCP protocol and provides efficient, up-to-date information about service status without exhaustive monitoring. Experimental results show that the monitoring algorithm provides significant benefits when compared to the more exhaustive methods. This approach also facilitates other service activities, such as cross cloud service discovery.

Keywords: *Adaptive Service Management, Cloud Computing, Information Technology, Service Monitoring, Web Services*

INTRODUCTION

Service-Oriented Computing (SOC) principles and web services provide flexibility in Internet operations. Web services are loosely coupled, self-contained, and network enabled software components that realize a specific task (Papazoglou, 2003). With standards such as WSDL, SOAP, and REST, web services are widely adopted in domains such as e-commerce, sci-

entific workflow, and distributed and embedded systems.

Cloud computing is a recent paradigm that builds on previous computing paradigms such as grid computing and utility computing (Armbrust, 2010). Traditional computing capabilities such as CPU hour, storage capacity, network bandwidth and even software functionalities are flexibly configured and commoditized by cloud computing frameworks. Typically, for

each cloud, there is a single cloud provider responsible for managing and maintaining the cloud resources. Multiple cloud users can request resources from the provider. These users can be cooperative, as in a company's private cloud, or mutually untrusted, as in a public cloud. The cloud provider provisions resources based on users' requests and availability of the requested resources.

As more and more companies are advertising their services on the web, effective service discovery and management has become a critical aspect of service-oriented computing. At the same time, as cloud computing grows in maturity and gains more acceptances, it will likely become a primary distributed computing paradigm in the future. Consequently, a natural strategic move for service providers is to offer services deployed in cloud computing frameworks (Wei, 2010). Hence for service developers and users, providers' cloud settings will be the primary location for finding desired services. Examples of services that are already offered by cloud-based service providers include Customer Relationship Management (CRM) services, Enterprise Resource Planning (ERP) services and email exchange services.

The growing number of service activities in cloud environments requires a highly efficient framework that promotes service advertisement, management and discovery operations. A framework that is capable of scanning and incorporating service specifications across multiple cloud providers facilitates higher-level, cloud provider-situated knowledge bases that will, in effect, federate cloud environments with respect to their services. However, such an environment requires intelligent or agent-based capabilities to adapt to the highly-dynamic environment. In this paper, we introduce a supporting software framework for agent-based services in cloud environments, as well as an adaptive algorithm to monitor deployed services. The algorithm has the ability to adaptively adjust service status checking time intervals based on different check responses. This framework reduces the number of messages required to

check the status of services (as shown in our simulation results).

The remainder of this paper is organized into the following sections. In the next section we discuss the challenges in service-cloud integration. We also presented a brief survey on related work in this section. After that, we introduce a framework for agent based services and an adaptive monitoring algorithm. A prototype implementation of the framework is described in Implementation and Evaluation section. Experimental results and analysis are also presented in the same section. Conclusions and future work are described in the last section.

CHALLENGES AND RELATED WORK

Challenges of Service-Cloud Integration

Web-based service repositories (such as Seekda (2011) and ProgrammableWeb (2011)) and service search engines (such as Woogle (Dong, 2004)) tend to leverage user efforts and/or web crawlers to find potential web services available on the open Internet. However, the Web is a heterogeneous environment, so for different services, how it is deployed and what technology is used can vary greatly. Moreover, the availabilities of the discovered services are usually not identical and there is no monitoring mechanism for those services so that users can acquire the latest information about them. Thus, the unstructured, perhaps disorganized, nature of services published through these means poses a challenge for service advertisement, management and integration. The emergence of cloud environments provides a suitable location for more organized and more effective service management and utilization. However, in order to achieve this goal, several challenges must be addressed, such as:

1. What are best practices for modeling services in cloud settings?

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