Chapter 1
Cloud Federations: Requirements, Properties, and Architectures

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ABSTRACT

With the maturation of the Cloud Computing, the eyes of the scientific community and specialized commercial institutions have turned to research related to the use of multiple clouds. The main reason for this interest is the limitations that many cloud providers individually face to meet all the inherent characteristics of this paradigm. Therefore, using multiple cloud organizations opens the opportunity for the providers to consume resources with more attractive prices, increase the resilience as well as to monetize their own idle resources. When considering customers, problems as interruption of services, lack of interoperability that lead to lock-in and loss of quality of services due to locality are presented as limiting to the adoption of Cloud Computing. This chapter presents an introduction to conceptual characterization of Cloud Federation. Moreover, it presents the challenges in implementing federation architectures, requirements for the development of this type of organization and the relevant architecture proposals.

INTRODUCTION

Cloud Computing (Mell & Grance, 2011) has emerged as a vedette in information technology in the 21st century, presenting a paradigm shift on how computing capacity is acquired by consumers. In this paradigm, computing resources of various kinds are offered as a service in the form of utilities, where users pay according to their necessity for computing power. Computing services in clouds can be offered at three different levels, according to the computing object being offered: (i) Infrastructure as a Service (IaaS), offered to infrastructure management clients; (ii) Platform as a Service, offered to application

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Cloud Federations

development clients; and (iii) Software as a Service (SaaS), offered to the application’s final users. The most prominent characteristic that makes cloud computing attractive is the elasticity, which allows management of computing power, increasing or decreasing it, according to the workload. For cloud clients, elasticity allows cost reduction and avoidance of upfront investments in computing infrastructure. On the other hand, providing elasticity is a challenging technical issue that must be tackled by cloud providers.

Elasticity provisioning is inherent to the amount of physical resources (e.g., CPU) that each cloud provider has on its datacenter(s). Therefore, resource exhaustion can compromise service offering to cloud clients, as well as hamper the quality of services already running, especially in small- and medium-sized cloud providers. Other limiting factors of monolithic clouds (where a provider is a single, isolated, domain) include the business continuity problems in case of unexpected faults that cause service disruption (Toosi, Calheiros, & Buyya, 2014; Grozev & Buyya, 2012); the challenging issues related to lack of geographical dispersion, which can affect quality of service; and lack of interoperability with other providers (Grozev & Buyya, 2012; Assis, Bittencourt, & Tolosana-Calasanz, 2014). In face of such limitations, a need for evolution of this technology arises, where solutions of multiple clouds started to be designed and deployed.

Along with the multiple clouds solutions recently proposed, such as Multi-Clouds (Kurze et al., 2011; Grozev & Buyya, 2012; Toosi et al., 2014) and Sky-Computing (Keahey, Tsugawa, Matsunaga, & Fortes, 2009), the Cloud Federation can be highlighted as a voluntary association of clouds subject to a federative contract that defines the behavior (duties and penalties) of participating entities. In this chapter we define and discuss properties, opportunities, challenges, current research state and development of Cloud Federations.

The remainder of this chapter is organized as follows: the Background section presents the characteristics of Cloud Computing in detail. The definition of Cloud Federation, the motivations to the emergence of this kind of association, the open challenges in Federations, and the identified characteristics are presented in Cloud Federations: Motivations and Challenges section. The Cloud Federations Properties section describes the properties identified in cloud federations. In Architectural Specifications, Blueprint and Existing System section, some of the main federation architectures available in the literature are presented, followed by the concluding section.

BACKGROUND

This section aims to provide insight for understanding the rest of the document. It presents the Cloud Computing paradigm, exploring its main properties, delivery and deployment models, as well as covering their characteristics and key elements.

Cloud Computing

The term Cloud Computing has frequently been used as a synonym for technological advancement. However, there is not a uniform understanding of its meaning, which is mainly due to the overloading of multiple related concepts behind the term Cloud.

As quoted in the compilation of cloud-related work performed by Vaquero et al. (Vaquero, Rodero-Merino, Caceres, & Lindner, 2008), some authors as Watson et al. (Watson, Lord, Gibson, Periorellis, & Pitsilis, 2008) and Geelan et al. (Geelan et al., 2008) define Cloud Computing as a novel computing