Chapter 11
On the use of the Hybrid Cloud Computing Paradigm

Carlos Martín Sánchez  
Complutense University of Madrid, Spain

Daniel Molina  
Complutense University of Madrid, Spain

Rafael Moreno Vozmediano  
Complutense University of Madrid, Spain

Ruben S. Montero  
Complutense University of Madrid, Spain

Ignacio M. Llorente  
Complutense University of Madrid, Spain

ABSTRACT
This chapter analyzes the Hybrid Cloud computing model, a paradigm that combines on-premise Private Clouds with the resources of Public Clouds. This new model is not yet fully developed, and there is still a lot of work to be done before true multi-Cloud installations become mature enough to be used in production environments. A review of some of its limitations and the challenges that have to be faced is done in this chapter, and some common techniques to address the challenges studied are also included. It also presents a Hybrid Cloud architecture based on the OpenNebula Cloud toolkit, trying to overcome some of the challenges, and present some real-life experiences with this proposed architecture and Amazon EC2.

INTRODUCTION
Nowadays, Infrastructure as a Service (IaaS) Clouds are considered a viable solution for the on-demand provisioning of computational resources. Since its popularization in 2006 by the Amazon Elastic Computing Cloud (EC2), the IaaS paradigm is being adopted by many organizations not only to lease resources from a Cloud provider, but also to implement on-premise IaaS Clouds. The former, and original usage, is usually referred to as Public Clouds while the latter is commonly named Private Cloud (Sotomayor, Montero, Llorente, & Foster, 2009; Rochwerger et al., 2009).
Public as well as Private Clouds have rapidly evolved since the advent of the IaaS Cloud paradigm. The public IaaS market has been enriched with multiple providers each one with different price model and offers, Cloud interfaces and APIs and even a set of disparate features. The private ecosystem is not different and multiple technologies both open-source and private can be used today to build on-premise Clouds. Again the features, characteristics and adoption levels greatly vary among these technologies (Moreno, Montero, & Llorente, 2009).

Private Clouds were designed to address specific needs that are missing in a Public Cloud, namely: (i) security, sensible data may not be stored nor processed in an external resource; (ii) legal constraints, the laws of most countries impose several limitations on the geographical location of digital data; and (iii) on-premise infrastructures, most organizations rely on their own resources to address the most important computational needs. Although there are reasons for Private Clouds to exist, they present some of the traditional problems associated with running a data-center that Public Clouds try to mitigate, notably adjusting its dimension so the utilization is maximized while satisfying a given demand.

The solution to this problem is usually termed as Hybrid Cloud computing. A Hybrid Cloud combines an on-premise Private Cloud, to satisfy the average or sensible demands, and a Public Cloud, to outsource resources for low security or peak demands.

This chapter will analyze the Hybrid Cloud computing model, starting with its classification as a kind of Cloud Federation in the Background section. Then it will review of some of its limitations and some techniques to overcome these problems. It will also include some real-life experiences with this model using the OpenNebula Cloud toolkit and Amazon EC2. The chapter ends with a discussion on the future research directions and final conclusions.

**BACKGROUND**

Usually, computational resources needed by organization’s services are leased in the form of Virtual Machines (VMs) from the local infrastructure. Hence, these organizations are effectively transforming their rigid infrastructure into a flexible and agile provisioning platform.

A natural step for these companies is to outsource part of the computational capacity they need from an external provider. In this way, they can face peak demands in a cost-effective manner. Also, they can better serve user requests by moving some services to an external Cloud closer to the user, or implement high availability strategies federating different Cloud infrastructures.

The federation of Cloud infrastructures offers multiple benefits, such as the possibility of scaling-out the local data center with external resources of a remote Cloud; the possibility of aggregating resources from different Cloud infrastructures to increase the computing capacity; or the possibility of gaining access to different Cloud providers that offer different features, different types of resources, and different price schemes, allowing multi-cloud deployment of services based on cost and/or performance optimization criteria.

Although there is no general agreement on the classification of these architectures, the federation architecture models can be classified in the following four groups (Rochwerger et al., 2009):

- **Hybrid Cloud (Cloud bursting) architecture**: The Hybrid Cloud architecture, also called Cloud bursting, is a model that combines the resources of a Private Cloud with remote resources from one or more Public Clouds to provide extra capacity to satisfy peak demand periods. In this case the control over the Public Cloud resources is limited.

- **Cloud broker architecture**: This architecture is very similar to the Cloud bursting
Related Content

Product Complexity as a Determinant of Transaction Governance Structure: An Empirical Comparision of Web-Only and Traditional Banks
Aimao Zhang and Han Reichgelt (2008). Web Technologies for Commerce and Services Online (pp. 40-54).
www.igi-global.com/chapter/product-complexity-determinant-transaction-governance/31259?camid=4v1a

Marketing of Microfinance for Rural Women: Evidences from Rajasthan
www.igi-global.com/chapter/marketing-of-microfinance-for-rural-women/179990?camid=4v1a

Cloud Computing: The Future of Big Data Management
www.igi-global.com/article/cloud-computing/127105?camid=4v1a

Identifying the Contemporary Status of E-Service Sustainability Research
www.igi-global.com/article/identifying-the-contemporary-status-of-e-service-sustainability-research/127985?camid=4v1a