Chapter 2
Interoperable Resource Management for Establishing Federated Clouds

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ABSTRACT
Cloud Computing builds on the latest achievements of diverse research areas, such as Grid Computing, Service-oriented computing, business process modeling and virtualization. As this new computing paradigm was mostly lead by companies, several proprietary systems arose. Recently, alongside these commercial systems, several smaller-scale privately owned systems are maintained and developed. This chapter focuses on issues faced by users with interests in Multi-Cloud use and by Cloud providers with highly dynamic workloads. The authors propose a Federated Cloud Management architecture that provides unified access to a federated Cloud that aggregates multiple heterogeneous IaaS Cloud providers in a transparent manner. The architecture incorporates the concepts of meta-brokering, Cloud brokering, and on-demand service deployment. The meta-brokering component provides transparent service execution for the users by allowing the interconnection of various Cloud brokering solutions. Cloud-Brokers manage the number and the location of the Virtual Machines performing the user requests. In order to decrease Virtual Machine instantiation time and increase dynamism in the system, the service deployment component optimizes service delivery by encapsulating services as virtual appliances allowing their decomposition and replication among IaaS Cloud infrastructures. The architecture achieves service provider level transparency through automatic virtual appliance replication and Virtual Machine management of Cloud-Brokers.

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1. INTRODUCTION

Highly dynamic service environments (Di Nitto, 2008) require a novel infrastructure that can handle the on demand deployment and decommission of service instances. Cloud Computing (Buyya, 2009) offers simple and cost effective outsourcing in dynamic service environments and allows the construction of service-based applications extensible with the latest achievements in diverse research areas, such as Grid Computing, Service-oriented computing, and business processes and virtualization. Virtual appliances (VA) encapsulate metadata (e.g., network requirements) with a complete software system (e.g., operating system, software libraries and applications or services) prepared for execution in Virtual Machines (VM). IaaS Cloud systems provide access to remote computing infrastructures by allowing their users to instantiate virtual appliances (as a result, deploy service instances) on their virtualized resources as Virtual Machines.

Nowadays, several public and private IaaS systems co-exist and to realize dynamic service environments, users frequently envisage a federated Cloud that aggregates capabilities of various IaaS Cloud providers. These IaaS systems are offered either by public service providers — e.g. (Amazon EC2, 2011) or (Rackspace, 2011) — or by private entities (e.g. universities or startup companies who typically offer smaller scale infrastructures). There are several scenarios to accomplish Cloud federations — e.g., Hybrid-, Community- or Multi-Clouds (A. J. Ferrer et. al., 2012). This chapter, focuses only on the Multi-Cloud federation scenario where the Cloud user plays a central role, because the different infrastructure providers are used separately.

This chapter identifies two major scenarios when users switch IaaS systems: dissatisfaction and extension. When the users get dissatisfied with their currently used provider, they inevitably face the issue of provider lock in – all its applications and data are stored at the specific provider. This chapter is focused on compute intensive applications only; therefore, data lock in is not discussed. However, there is a need for an efficient way to transform applications for new providers. As Cloud adoption becomes more widespread, more and more users start using privately constructed proprietary IaaS systems. Nevertheless, users with strong workloads face the limitation of these providers. In mission critical situations or high demand periods, these users are willing to outsource a small percentage of their workloads to third party providers. This chapter identifies the following challenges for federated Cloud usage: (i) single IaaS entry point, (ii) Cloud selection, (iii) Virtual Machine management (termination, reuse or repurposing policies and IaaS specific VM operations), (iv) demand based virtual appliance distribution, (v) coping with software and hardware failures and varying load of user requests, (vi) establishing interoperability and (vii) minimizing Cloud usage costs. The way these challenges are addressed is detailed in the next paragraphs.

This chapter proposes and conceptually discusses an autonomic resource management solution that serves as an entry point to Cloud federations by providing transparent service execution for users. This solution incorporates and builds on top of the already proven concepts of meta-brokering (Kertesz, 2010), Cloud brokering (Marosi, 2011) and automated on-demand service deployment (Kecskemeti, 2011). Thus this chapter concentrates on the techniques that led these concepts towards the formation of Cloud federations. The meta-brokering component directly interacts with the user and acts as the single entry point to the system (the challenge (i)). Its interface offers Cloud selection facilities (the challenge (ii)) to identify the suitable IaaS providers for user requests. Cloud-Brokers are responsible for managing (challenge (iii)) and optimizing the usage costs (challenge (vii)) of the