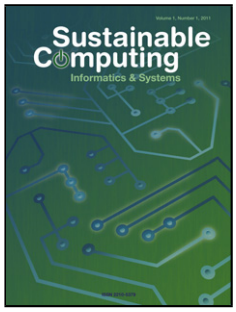

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An Architecture to Stimulate Behavioral Development of Academic Cloud Users☆

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Abstract

Academic cloud infrastructures are constructed and maintained so they minimally constrain their users. Since they are free and do not limit usage patterns, academics developed such behavior that jeopardizes fair and flexible resource provisioning. For efficiency, related work either explicitly limits user access to resources, or introduce automatic rationing techniques. Surprisingly, the root cause (i.e., the user behavior) is disregarded by these approaches. This article compares academic cloud user behavior to its commercial equivalent. We deduce, that academics should behave like commercial cloud users to relieve resource provisioning. To encourage commercial like behavior, we propose an architectural extension to existing academic infrastructure clouds. First, every user's energy consumption and efficiency is monitored. Then, energy efficiency based leader boards are used to ignite competition between academics and reveal their worst practices. Leader boards are not sufficient to completely change user behavior. Thus, we introduce engaging options that encourage academics to delay resource requests and prefer resources more suitable for the infrastructure's internal provisioning. Finally, we evaluate our extensions via a simulation using real life academic resource request traces. We show a potential resource utilization reduction (by the factor of at most 2.6) while maintaining the unlimited nature of academic clouds.

Keywords: Cloud Computing, Pricing, Infrastructure as a Service, Energy Awareness, Academic Clouds

1. Introduction

Academic computing infrastructures are built and maintained in order to support scientific users in their research endeavors. Introducing limitations on the hardware usage in any ways would defeat the very reason for the existence of these infrastructures. However, the more limitless a system is the more responsibility it requires from the scientific users. For example, they must learn to eliminate their impact on other user's workings. Therefore, maintainers of such systems traditionally make the compromise of introducing such limitations for the users that stop unintentional obstructions on the work of other users [1]. Meanwhile, for future systems, computer science tries to reduce the amount of limitations and their impact on the scientific users.

Infrastructure as a service (IaaS) cloud computing systems [2] are amongst the most recent developments in this field. These systems offer on demand resource access with such flexibility in software configurations [3] that the users could even utilize highly customized operating systems and support environments for their tasks. This flexibility is achieved through the application of virtualized data centers. Although, the cloud computing concept has been proposed by commercial companies (e.g., Amazon[1], Rackspace[2]), academic solutions (like Eucalyptus [4], Nimbus [5] or OpenNebula [6]) started to arise first by imitating the behavior of the commercial solutions then by advancing towards specific academic needs.

Pricing is one of the essential aspects of commercial IaaS systems [7] that academic solutions did not copy. Thus academic providers who apply such academic solutions will appear as offering unlimited resources for free to academic users. This promise is tempting for the users as it lifts one of their last remaining limitations. Unfortunately, this setting leads to an unprecedented demand of resources that is often latent (e.g., users maintaining demand for resources similarly to pilot jobs in grids [8]).

Academic providers have to fulfill these demands with the limited physical resources they are operating on. To meet the demands with the infrastructure's real capabilities they usually apply two solutions: (*i*) access rationing, (*ii*) under provisioning (N to 1 mapping of virtual to physical resources). Both approaches were utilized in academic infrastructures even before the cloud era, but they both

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[1] http://aws.amazon.com/ec2
[2] http://www.rackspace.com/