Chapter 5
Cloud Computing for Education and Research in Developing Countries

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ABSTRACT
Recently cloud computing has offered attractive solutions for academic and research institutions due to several reasons. In this chapter, the authors present a study of how cloud computing can be used for research and teaching activities in higher educational and research institutions in developing countries. Instead of focusing on cloud computing offering for basic IT infrastructures used in daily work of these institutions, the authors concentrate on the use of cloud computing for satisfying ad hoc needs of computing resources in research and teaching activities. Thorough analyses of research and teaching activities, requirements for cloud computing, benefits of utilizing cloud computing, and adoption barriers for these activities are also included. The authors then present the selected challenges in tackling these barriers and discuss possible approaches for solving these challenges and report lessons learned and experiences in utilizing and developing cloud computing solutions for teaching and research activities in Vietnam.

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INTRODUCTION

Cloud computing promises a new way of provisioning elastic computational resources and software applications by enabling people to have timely access to resources and services, with reasonable costs, guaranteed SLA and reduced entry effort and investment (Hayes, 2008) (Creeger, 2009) (Armbrust, et al., 2010). This vision is attractive to research and educational groups in many developing countries where even big academic and research institutions are still lacking resources (and funding for acquiring resources) to sufficiently support their research and education activities. For research and educational groups without adequate computing resources in developing countries, cloud computing offerings could be a viable solution. However, for their research and teaching activities these groups face not only with common issues in accessing large computational resources and having short-time research plans, but also several other constraints in terms of technological infrastructure (e.g., network performance), educational objectives (e.g., mastering advanced technologies developed in developed countries) and economy (e.g., lack of money even for a short research plan).

While, from an economic perspective, it seems that cloud computing would be one of the best solutions for such groups, one of the important aspects needs to be considered is what technical and educational factors could impact on the selection of cloud solutions as well as how cloud computing features could be customized to support their adoption by existing groups in developing countries. In this chapter, we will analyze requirements and research issues. We will then present research approaches and our experiences in developing and adopting cloud computing technologies for research and educational groups in Vietnam. Our expectation is that this analysis will help to increase the awareness of cloud computing for education and research as well as to reduce barriers in adopting cloud technologies in the context of developing countries.

The rest of this chapter is structured as follows. We discuss background and related work in Section Background and Related Work. Then, we analyze characteristics and requirements for cloud computing from academic institutions in developing countries in Section Characteristics and Requirements of Academic Institutions in Developing Countries. In Section Potential Benefits of Cloud Computing and Adoption Barriers, we analyze in detail how cloud computing can address requirements of academic institutions and which adoption barriers exist. We then present research challenges and approaches in order to deal with identified adoption barriers in Section Research Challenges and Approaches. Section Experiences presents our lessons learned and experiences in developing cloud-based solutions to support research and teaching activities in Vietnam. We discuss and conclude our work in Section Discussion and Conclusion.

BACKGROUND AND RELATED WORK

Cloud computing and its delivery forms, such as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS), have been well explained in several works (Mell & Grance, 2009) (Creeger, 2009). Similarly, what constitute “developing countries” has been given in (Wikipedia, 2011). In this work, we examine research and educational groups in higher educational and research institutions in developing countries. The groups in our work are defined with the following characteristics:

- **Groups do not have access to adequate resources for research and teaching activities**: Not all groups in higher educational and research institutions in developing countries are lacking of computing resources