

# Chapter 5

## Model of E-Education Infrastructure based on Cloud Computing

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### ABSTRACT

*With rapid increase in the number of users, services, educational content, and required resources, educational institutions face new challenges in design and deployment of IT infrastructure for e-education. This chapter deals with defining and developing a model of IT infrastructure for e-learning by using cloud computing concept. The first challenge is adoption and implementation of digital identity management systems and the second is providing support for a system that would be able to use all advantages of federation systems for digital identities management. The experimental part of the chapter consists of a study directed towards the validation of the proposed IT infrastructure model for e-learning. Research was conducted in the Laboratory for E-Business at the Faculty of Organizational Sciences. The results of the research show that the implemented model of IT infrastructure enables the system of e-learning to be more efficient, flexible, and more economical.*

### INTRODUCTION

Modern information and communication technologies are used on a daily basis for communication, collaboration, retrieving information and other services. Development, availability and accessibil-

ity of these technologies lead to new paradigms in teaching and learning processes. Nowadays, many universities in the world organize courses and trainings via distance learning systems. The number of users and the quantity of content within these systems grows rapidly. Therefore, the design and implementation of these systems become more complex. With a huge growth in the number of

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users, services, education contents and resources, e-learning systems become more and more large-scale. One of the basic problems in developing a model of infrastructure for e-education is how to provide scalability and reliability of educational applications and services.

This chapter discusses one possible approach for providing reliability and scalability of an e-education system for a higher education institution. The developed model for e-learning is based on cloud computing infrastructure. The model includes all services necessary for the implementation of activities in educational institutions and services for scientific research. The rest of the chapter is organized as follows: in the second chapter, a theoretical background on application of cloud computing as infrastructure for e-learning has been given; the third chapter describes the proposed model for implementing e-learning infrastructure through cloud computing; chapter four gives details on the realization of the proposed model within the e-learning system of Laboratory for e-business at University of Belgrade; in chapter five results on evaluation of the implemented infrastructure are presented. Finally, concluding remarks are given.

The main objective of this chapter is to provide a preview of development and realization of model for e-learning which is based on cloud computing infrastructure in a higher education institution. Proposed model is developed in aim to provide scalability and reliability of educational applications and services.

## **THEORETICAL BACKGROUND**

Talking about application of cloud computing infrastructure in higher education, three basic approaches can be noticed. First approach is complete outsourcing of e-education infrastructure (Sultan, 2010) which educational institutions provide to their users (teaching staff, administrative staff, researchers, students, etc.) with services such as

e-mail, digital libraries, etc., through the leased infrastructure of a cloud provider. Second approach is cloud within the private infrastructure (Caron, Desprez, Loureiro, & Muresan, 2009) that requires highly skilled cloud administrators and appropriate hardware and software resources within the educational institution. Third approach represents combination of previous two approaches (Costanzo, Assuncao, & Buyya, 2009). The educational institution can develop and deploy its own cloud infrastructure. If the infrastructure becomes overloaded, a third party cloud services can be leased in the periods of increased demand.

In the previous years, there has been much research in the field of cloud computing. However, only a few dealt with the problem of developing and deploying models for e-learning infrastructure using cloud computing. Main research directions important for the problems considered in this chapter include: identity management within cloud computing environment, modelling the cloud computing infrastructure, analyzing performances of the cloud computing, and resource management in e-learning systems.

The problem of identity has been present from the beginning of the mass use of the Internet. Nowadays, every user has multiple different digital identities, so that in the today's modern and quite scattered systems, the activity of authentication and authorization when accessing services is a problem for both users and system administrators. This problem also reflects in e-learning systems in higher education institutions, where different resources and services are often deployed through heterogeneous systems. Much research has proved that security, digital identity and access management are essential for successful deployment of infrastructure for e-learning (Zhang & Chen, 2010; Zhang & Chen, 2011). The aim of identity management systems is to establish a connection between identifiers of different services, so that information about the user associated with the identifier can be integrated. In this way, the system connects identity management business processes,

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