An Architecture Paradigm for Providing Cloud Services in School Labs Based on Open Source Software to Enhance ICT in Education

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ABSTRACT

The authors present their experience and practices of introducing cloud services, as a means to simplify the adoption of ICT (Information Communication and Technology) in education, using Free/Open Source Software. The solution creates a hybrid cloud infrastructure, in order to provide a pre-installed (Ubuntu and Linux Terminal Server Project) virtual machine, acting as a server inside the school, providing desktop environment based on the Software as a Service cloud model, where legacy PCs act as stateless devices. Classroom management is accomplished using the application “Epoptes.” To minimize administration tasks, educational software is provided accordingly, either on-line or through repositories to automate software installation (including patches and updates). The advantages of the hybrid cloud implementation, include services that are not completely dependent on broadband connections’ state, minimal cost, reusability of obsolete equipment, ease of administration, centralized management, patches and educational software provisioning and, above all, facilitation of the educational procedure.

Keywords: Architecture, Hybrid Cloud, ICT (Information Communication and Technology), LTSP (Linux Terminal Server Project), School Labs

INTRODUCTION

The importance and prevalence of Information and Communication Technologies (ICT) in education is universally recognized, because of their potential to create more comprehensive educational material that ameliorates the academic development of children (Kalaš, 2010). Despite this fact, ICT introduction did not meet their initial (since 90s) expectations (Watson,
Since early 2000s many national and international studies (Kozma, 2003; OECD, 2006; Pelgrum, 2001) depict the fact that there is a serious gap between the theoretical enhancement that will result by exploiting ICT in education and the actual application of ICT in a classroom.

Some of the obstacles mentioned above, are mainly technical issues related to the schools’ networking, computing and building infrastructures. In Greece for example, computers are part of a local area network and are communicating using the client – server computational model, which requires administration of all components (all the clients and the server). Due to the technological evolution and the software and hardware prerequisites of educational software, many school labs’ computers need to be replaced. Unfortunately, the goal of procuring and maintaining computer labs to satisfy the requirements was impractical due to limited resources. To make things worse, in order to achieve a 1:1 student to computer ratio more computers are needed, not to mention that the lack of technical personnel to support the ICT infrastructure impairs all the aforementioned issues (Kondilis et al., 2007). In 2006, a new computational model, the thin client model (Becta, 2004; Nieh et al., 2005), was introduced, taking advantage of Linux Terminal Server Project (LTSP) package (Balneaves et al., 2009) and Ubuntu (http://www.ubuntu.com) operating system, aiming to replicate successful references of other countries (Braaten et al., 2002; Reinholdtsen, 2002; Carter et al., 2004). Old PCs could be reutilized and students had accepted thin client performance as well as Ubuntu’s application environment, but there were still technical issues with regards to the installation and everyday usage and administration (Kondilis et al., 2008). In this paper, cloud services are introduced as a means to simplify and enhance the adoption of ICT technologies, rendering the outdated infrastructure of school labs as adequate client machines, capable of providing all the functionality that is essential within the school environment, while open source software is employed. The rest of the paper is structured as follows: First, we present the cloud computing model and its services. An analysis of the requirements is presented afterwards, while explanations of how the proposed architecture conforms to the previous requirements along with the technical issues of the customization procedure are quoted in the section after that. Results derived from schools that adopted the solution are then presented. We then discuss concerns about current trends aiming to utilize students’ mobile devices and then summarize and conclude the paper.

CLOUD COMPUTING AND ITS SERVICES

Recently, available computing resources are cheaper and more powerful than ever before, resulting in the emergence of a new computing model called cloud computing, one of the hottest topics in ICT today (Zhang et al., 2010; Sultan, 2010; Grossman, 2009; Vouk, 2008), while it is also considered to be the next stage in the evolution of the Internet. IT vendors spend billions of dollars to create infrastructures that provide cloud solutions and therefore creating more research opportunities on this field. Strange though it may seem, there is not a standard definition of the cloud, as its services are being utilized by various computing models and the term “cloud computing” is used to imprint several diverse things. Current ICT trends are about data center consolidation, server virtualization, using thin client devices (such as an internet browser), whilst broadband connections are the cornerstone. Cloud computing is considered a comprehensive solution that delivers IT as a service; much like electricity is distributed on the electrical grid. Clouds, or clusters of distributed computers, provide on-demand resources and services over a network, usually the Internet, with the scale and reliability of a data center (Grossman, 2009; Armbrust, 2009).

Virtualization (Miller et al., 2007) is a key component for the cloud concept, as it enables greater flexibility in pooling and sharing the IT resources, therefore extending the previ-
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