Cloud e-University services

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Abstract. This paper examines and elaborates various electronic services used at universities on a world-wide level. Cloud e-University services provide learning help as well as practical knowledge for students, and enable teaching and administrative staff to fulfill their tasks through provided services and integrate various solutions into greater, encompassing platform for e-driven education. Electronic services include virtualization and Cloud services, computer clusters, GRIDs and storage, science and engineering software primarily used for development, video conferencing and distance learning services, social computing and support services, as well as Student Information Systems (SIS) and Student Lifecycle Management Systems (SLM). We give brief overview of how iKnow [1] functionalities can be mapped into ELF framework [2].

Keywords: e-University, cloud computing, SaaS, electronic services, E-Learning

1 Introduction

Higher education institutions are amongst the few organizations facilitating development and deployment of new technologies. Cloud computing today is becoming "old news", but this status is reached through no small effort and support of Universities around the world. Their role in Cloud computing development varies, from initial designers and developers, through consulting and participation in cloud services testing, and consumers of end-user solutions on the other end of the spectrum. Therefore, we can safely say that Universities today are more and more becoming e-Universities, given the amount of electronic services developed, deployed, and consumed.

Universities, as leading researchers and innovators of new technologies have eagerly adopted benefits provided through Cloud computing, and developed various means to exploit these virtual resources.

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For implementing a complete e-University system there are plenty e-Learning Framework variations developed throughout the years. On Figure 1, we present working e-Learning Framework developed through coordinated efforts of U.K Joint Information Services Committee (JISC) and Australia Department of Education, Science and Training (DEST) [3]. This Framework recognizes 59 distinct functionalities divided into three main groups: Sample User Agents, Learning Domain Services and Common Services.

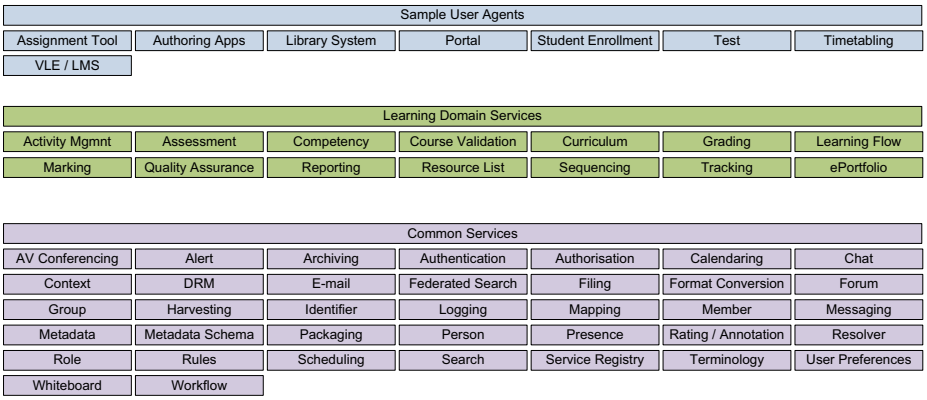
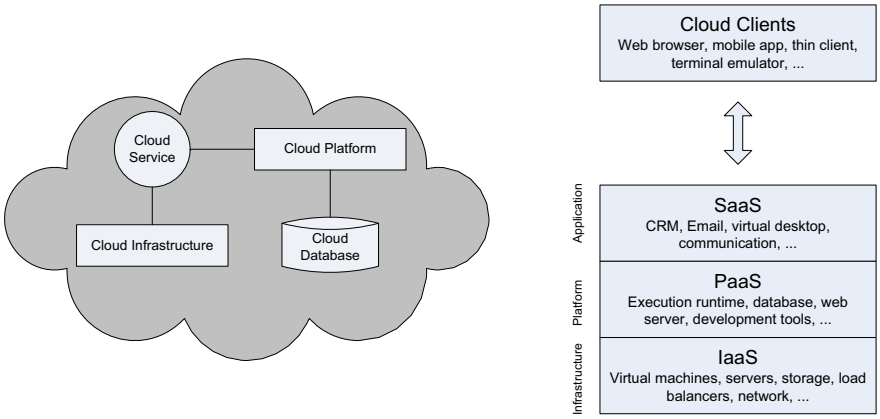


Fig. 1 The E-Learning Framework.

2 Cloud implementation of University student services

According to [4] there are "…[besides Service Oriented Architecture] two other common ways of integrating systems, which are to integrate at the user interface level using portals, or at the data level by creating large combined datasets or data warehouses." Out of these words, one can clearly see why we propose Service Oriented Architecture as building and Web Services as delivering model for University-wide integrated and maintained electronic services solution. Both of the alternative approaches require highly trained IT professionals, data warehouses, servers and infrastructure than any faculty possesses on its own.

A sample Cloud architecture and cloud computing service levels are shown in Figure 2. Figure 2(a) shows simple cloud architecture, where data from database residing in the cloud is providing cloud service using cloud based platform. All of these components are using cloud infrastructure, typically a Virtual machine, and are connected using loose coupling. Figure 2(b) illustrates 3 service levels in cloud computing, namely, Infrastructure as a Service, Platform as a Service and Software as a Service. Cloud clients use provided service through appropriate application.



a) b)

Fig. 2 (a) Cloud architecture, and (b) cloud computing service levels.

According to objectives stated in [5], "…university information system should automate the overall business processes of the university. … organize student data, employees, study programs, various data about the educational process and the faculty's research and scientific work. … automate the work of the student service, human resources management, schedule of lectures, management of student payments on various grounds, distribution of resources (professors and classrooms), organization of online services for the students and various other activities…"

According to [6], "…Cross-institutional cooperation [in Macedonia] by sharing information is a need which arises, because many courses [at Universities] are beginning to be taught collaboratively realizing the concepts of student mobility and lifelong learning…". Therefore, realizing iKnow system as cloud service(s), should become one of the most important goals for the next period, since interoperability and standardization of data and services is one of the benefits when using cloud infrastructure.

For example University Sts Cyril and Methodius, started the iKnow project [1] to establish a central placeholder for ideas, requirements, functionality descriptions and activities toward designing and developing Student Information Services and Student Enrolling platform. This solution consists of five modules, and is intended to implement 76 identified basic functionalities. Most of functionalities are specific only to one module, but there is a number of functionalities shared between modules, where Core module is involved in all of those situations.

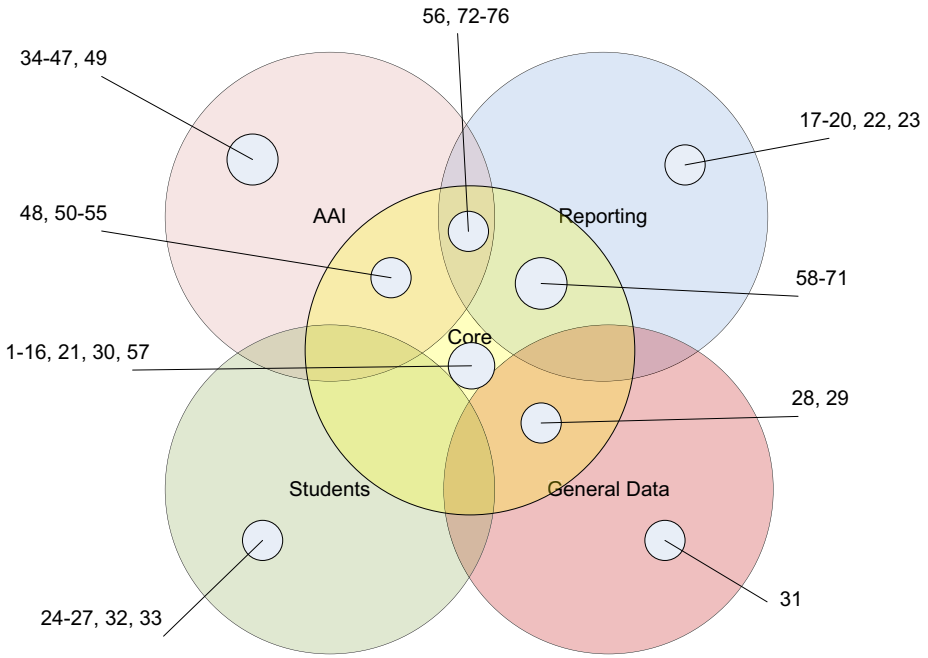


Fig. 3 iKnow system defines 5 modules and 76 basic functionalities [1].

Our goal is to provide insight into adjusting these services for cloud computing. In this paper we will not provide detailed description of needs and means to transform each and every service into cloud services. Rather, we will provide some suggestions how to divide responsibilities on service clusters, and general directions how to proceed to the desired goal – fully functional electronically driven University completely moved into the cloud.

The only requirement is that system must work, and must be reachable from any institution using its resources. What faculties need to do, is to provide their requirements regarding processing power, storage and bandwidth.

Regarding functionalities stated in provided project documents, we can make some additional observations, and give our ideas on improving service level and interaction. We recognize that full implementation of ELF framework through transformation of iKnow system into Cloud Computing solution will require substantial additional reworking.

Some of the cloud services beneficent for students and staff have been already implemented at the University, i.e. at the Faculty of Computer Sciences and Engineering. FCSE Computing Centre is using Microsoft's Live@Edu facilities in the form of Email service and SkyDrive as Cloud Storage [7]. Our experience is teaching us that these cloud services provide high-level functionalities without need to use technical resources and staff to implement, use and maintain these applications. Other educational institutions have positive experience with cloud services as well – for

example, various services at JISC CETIS (Centre for Educational Technology & Interoperability Standards) [8], such as Microsoft Live@Edu [9], Enrollment RX [10], Amazon Web Services [11], and so on.

3 Moving into cloud

Strategic Technologies Group at JISC CETIS in April 2011 organized Workshop [12], drawing a number of conclusions regarding cloud computing in higher education. In their view, there are a number of services suitable for moving into the Cloud, such as: Email, Travel expenses, Human Resources, Finance, Student network services, Telephone services, File storage and Infrastructure as a Service. They also postulated which services should stay "in house": Course and curriculum management, Admission process and Research processes. Another researcher at JISC CETIS, Yuan Li, formulates these conclusions with following observation [13]: "…Clearly, those are non core business or business critical to institutions are most likely to use cloud computing services. More complex, more customised data would be more difficult to move to cloud…". Clearly, in this context, "cloud" means public clouds, as opposed to private clouds, owned by service consumer.

Following these observations and [4], we provide our view on what iKnow functionalities can be moved to the cloud, and which should be institution governed. First, it should be mentioned that for some of the services, data should originate from faculties themselves and University, i.e. its Computer Center consumes that data; and with certainty, there are situations where Faculties use University provided services. Second, although we mention public and private clouds, it is recommendable for the initial phase, and services encompassed by iKnow project, only using private cloud (i.e. cloud owned by the University). Using functionality distribution among modules, illustrated on Figure 2, we briefly provide our view on functionalities' transfer into cloud.

After thorough analyzing, and mapping of ELF Services with appropriate iKnow functionalities, we divided all services into three tables, similar to division introduced by JISC CETIS E-Learning Framework. It is noticeable that a number of iKnow functionalities [1], such as functionalities regarding Administration and pricing, various reports intended for information exchange with Ministry and Statistical Office, do not map into ELF services. These functionalities can be implemented as SaaS, but require additional reworking.

iKnow Services supported by AAI module – involving services such as wireless infrastructure, authentication and authorization services, and so on - can be directly implemented as IaaS at the University level; at the same time, there is a number of iKnow functionalities directly mapping into ELF services, which require transformation from web application into web services available for different higher education institutions. In fact, most of iKnow functionalities can be mapped into Sample User Agent and Learning Domain Services, while requiring SOA approach.

4 Conclusions

In this paper, we have presented how a number of iKnow services can be mapped into ELF framework, thus becoming fully functional "as a Service" solution. From our brief introduction of offered services, we can see that most of the Universities have consolidated their computer centers and offer various cloud and non-cloud solutions. It is also evident that cloud solutions offered, present mix of various in-house and outsourcing solutions, such as Google Apps, Microsoft's Live@Edu, and others.

We have also offered insight into our past experience with various cloud solutions, which are positive, and encourage further investment in this direction. Computer Center at FCSE is also working on various cloud infrastructures and on establishing Authentication and Authorization Infrastructure with Shibboleth, which could be used at University-wide level.

iKnow system, intended to provide more than seventy five important functionalities which will enable concerned parties at Universities in Macedonia to fulfill several very important business processes, can only benefit from moving its functionalities into the cloud. We gave our arguments for this transfer, firmly believing that it will provide numerous benefits, such as increased interoperability, central bookkeeping and data warehousing, tightened security, campus-wide authentication and authorization, and so on

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