

E-Learning Portal Architecture – From Web Services towards Cloud Services

Alina Andreica*, Florina Covaci*, Daniel Stuparu*, Gabriel Pop*, Călin Miu*, Romulus Gadi**, Flavius Chira**,
Grigorie Bogdan Mărcuș**, Cosmin Tarța**, Cristina Câmpeanu**

IT Department, Babes-Bolyai University, Cluj-Napoca, Romania *

{alina.andreica, florina.covaci, daniel.stuparu, gabriel.pop, calin.miu}@ubbcluj.ro *

Net Brinel SA, Cluj-Napoca, Romania **

{romulus.gadi, flavius.chira, grigorie.marcus, cosmin.tarta, cristina.campeanu}@brinel.ro **

Abstract— The present paper focuses on architecture principles for providing integrated e-learning services both as web services and as cloud services, technology that presently emerges as ‘on-demand’ services. The information system facilities are made available by integrating into a global web portal the dedicated services and synchronizing databases based on various technologies. The web portal architecture that currently comprises e-learning and dedicated information systems facilities is extended with cloud on-demand facilities. The classical portal architecture, based on MS technology, provides, as learning services, management content and e-learning facilities for various user categories, as well as dedicated information system facilities. We design the extension of the this architecture with on-demand services in the cloud using Office 365, which provides cloud services for e-mail, office applications and collaboration tools and we envision the impact of the new architecture. The described services, which are available on-demand, partly hosted in the cloud, create an “intensive” focused architecture that may be applied for various organization cases.

Keywords- *system integration; database synchronization; e-learning; on-demand & cloud services; web portal.*

I. INTRODUCTION AND WORKING FRAMEWORK

Information system integration is a very important issue for present organizations and has been tackled in the literature especially for business and organizational processes [12]. System interoperability has also been dealt with from a semantic point of view [13].

System integration is best solved within a single sign-on framework. The problem of managing uniform user identities in organizations is addressed by Shaw [16] within a management access system for a framework with different user identities in specific information systems (Quest OneIdentity Solution). The solution relies in building an unified identity and access management system – IAM within the organization, consolidating multiple identities in one (integrated) identity. The IAM approach [16] simplifies identity access and management within the organization, improving security and productivity, and providing single sign on, role management, multiple authentication and password management facilities. IAM complexity may be managed with [16]: (1) point solutions, which implement a password reset within a system and then synchronize it with

the others, or (2) IAM frameworks, which implement a specific IAM solution based on already developed frameworks: IBM (Tivoli Identity Manager), Oracle, Novell, MS Forefront Identity Manager FIM (Identity Lifecycle Manager - ILM). Our paper uses the latter approach. The FIM / ILM server provides automated synchronization mechanisms that enable the integration of Active directory with other services, like SQL, e-mail (OWA), chat, etc.

Universities also adopt information systems and integration solutions based on Oracle technologies [32]. Our option also takes into consideration the existing MS Academic Agreement from an IT strategy point of view [3].

In [6], [7], [8] we present the architecture of an e-learning portal for providing e-learning and dedicated information system services. The architecture, based on Microsoft technology, uses a FIM – Forefront Identity Manager [26] server, and additional interface modules, for integrating the dedicated information systems into the web portal that also provides e-learning facilities, based on SharePoint Portal functionalities. The proposed framework enables data and service integration that may be further exchanged within federated web services – see also [11], [20].

The paper describes the extension of this architecture with on-demand services hosted in the cloud. In this respect, we are going to use Office 365 cloud services for e-mail, office applications and collaboration tools.

Section 2 describes the present architecture integration principles. In Section 3, we present the web services that are provided within the portal, while Section 4 focuses on the new cloud services and on-demand facilities. Conclusions reveal the most important contributions of the paper.

II. SYSTEM INTEGRATION ARCHITECTURE

The integrated e-learning portal provides academic web-services: e-learning and dedicated information system ones. The portal integration with the dedicated information systems (AcademicInfo, ManageAsist, Research Management System in our case; see Section 3), is described further. The architecture we propose (see Fig. 1) is based on MS technology; we use an ILM – Identity Lifecycle Management – type server ensuring single sign-on capabilities and uniform interface to the dedicated information systems. Therefore, these dedicated facilities

will be mapped into the portal, together with supplemental web services – see Section 4.

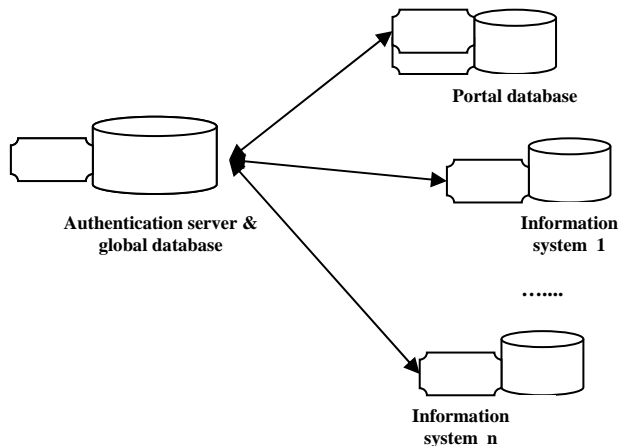


Figure 1. System integration architecture.

In order to access the dedicated information system facilities, we selected the user categories that have specific functionalities and designed, for each, an “access point” into the portal. Authentication is performed by the same account and password into the portal and into the information systems, i.e. credentials are the same for the portal and the accessed information systems. After portal login and credentials check, the logon information is retained as current session variables and further passed on towards the information systems; access points are designed in respect with the account permissions (in our case, user categories are students, academic staff and /or research staff, managers, secretariats). Each user category may have one or more roles, based on which we define access points into the dedicated information systems. Credentials are passed to the accessed information system as session variables and used in order to also perform authentication into the dedicated systems.

Permissions of each user category are retained in a global database, created by synchronizing the information systems’ databases with necessary information [7], [8]. In our case:

- *students* access their educational path (AcademicInfo system, see Section 3) and learning resources in view permissions (portal);
- *academic staff* access disciplines they teach and student grades (AcademicInfo [21]) and learning resources in design permissions, available facilities in the Research management system (activity upload, syntheses) and administrative facilities in ManageAsist system;
- *research staff* access their facilities in the Research management system (activity upload, syntheses) and administrative facilities in ManageAsist system;
- *managers* access educational syntheses (AcademicInfo), research and financial syntheses for the unit they manage (department, faculty, institute, university) - Research management and ManageAsist systems [9].

A. Database synchronization principles

Single sign-on correctness is dependent on the permission information, consequently on the database consistency; therefore, database synchronization is required.

The synchronization process will include the information systems’ databases and the portal database (Fig. 2). Database synchronization ensures global database consistency and updates access permissions both for the portal and the information systems; credentials logged in the portal will therefore be verifiable, within the global database, in respect with their permissions in the dedicated information systems.

The global synchronized database is based on the human resource & organization chart information, retained in dedicated tables, as described in [6]:

User[userid, account, password, unitid]

Unit[unitid, unitname, ...]

Organization_chart [unitid, superior_id, horiz_id]

This common database, used by the ILM server, also contains user and group authentication information, together with dedicated permissions in each of the information systems, in order to ensure access to corresponding permissions into the dedicated information systems. Permissions within the portal are implemented by means of dedicated groups. Active directory AD is provisioned with necessary information from the global database, using ILM as a synchronization interface (see Section 3).

Security issues are managed according to AD and ILM principles – see [25], [26]. Data privacy aspects are treated according to the legal regulation principles (for example student grades, teacher wages), and accessible only to their owners and may be processed within the dedicated systems according to organizational workflows.

The synchronization process is based on the dataflow sequences that occur in information processing; these sequences have to be defined in each organization case. In our case, the data workflow involves (Fig. 2, left hand side):

- 1. organization chart and user tables are replicated from ManageAsist into the global database;
- 2-3. these tables are afterwards sent into Research Management and AcademicInfo databases;
- 4. grant tables are replicated from Research Management into the global database;
- 5. these tables are then sent into ManageAsist database;
- 6. students, disciplines, educational data, fee tables - transferred from AcademicInfo into the global database;
- 7. these tables are sent into ManageAsist database [9]

The synchronization engine follows the above described steps 1-7; it searches Update, Insert and Delete operations and sends the corresponding information into the global database. Potential error messages are retained in a dedicated table from the global database. The synchronization process runs daily. First run time was around 7 hours, while current updates daily vary from 7 seconds to about 30 minutes, according to the updates that are performed on the databases. For an efficiency evaluation, current database dimensions are: AcademicInfo: 9.75GB (with 1.48GB data, rest – logs), ManageAsist: 4.52G, Research Management: 132M, UBBonline global database: 50.75GB (49.1GB, rest logs). A full permission restoration procedure, which sets single sign on permissions for ILM server, based on data provided by the dedicated systems (human resources, students, contract studies, etc.) runs daily, taking around 5 hours. Any potential errors are automatically logged and later analyzed; even if an

error occurs, the permission setting procedure is fully resumed the next day, so previous errors do not influence it, unless they occur consequent to some structural errors, which can be identified from the logs and solved.

The latter process is performed via the ILM server (MS SQL web) between the global database GDB and Active directory AD information (BDG – UBBonline portal link in Fig. 2). We use ILM’s connector space (MS SQL web) and two dedicated agents which transfer information from the global database, respectively from AD into the connector

space [9], compare it and synchronize the updated information from GDB into AD, updating therefore the necessary information in order to apply correct permissions within the portal access (ILM – OUs – UBBonline portal links in Fig. 2). The ILM server also performs the integration with AD and the SQL server managing UBBonline database, the e-mail server – MS Exchange and the communication server (see Fig. 2, lower right hand side).

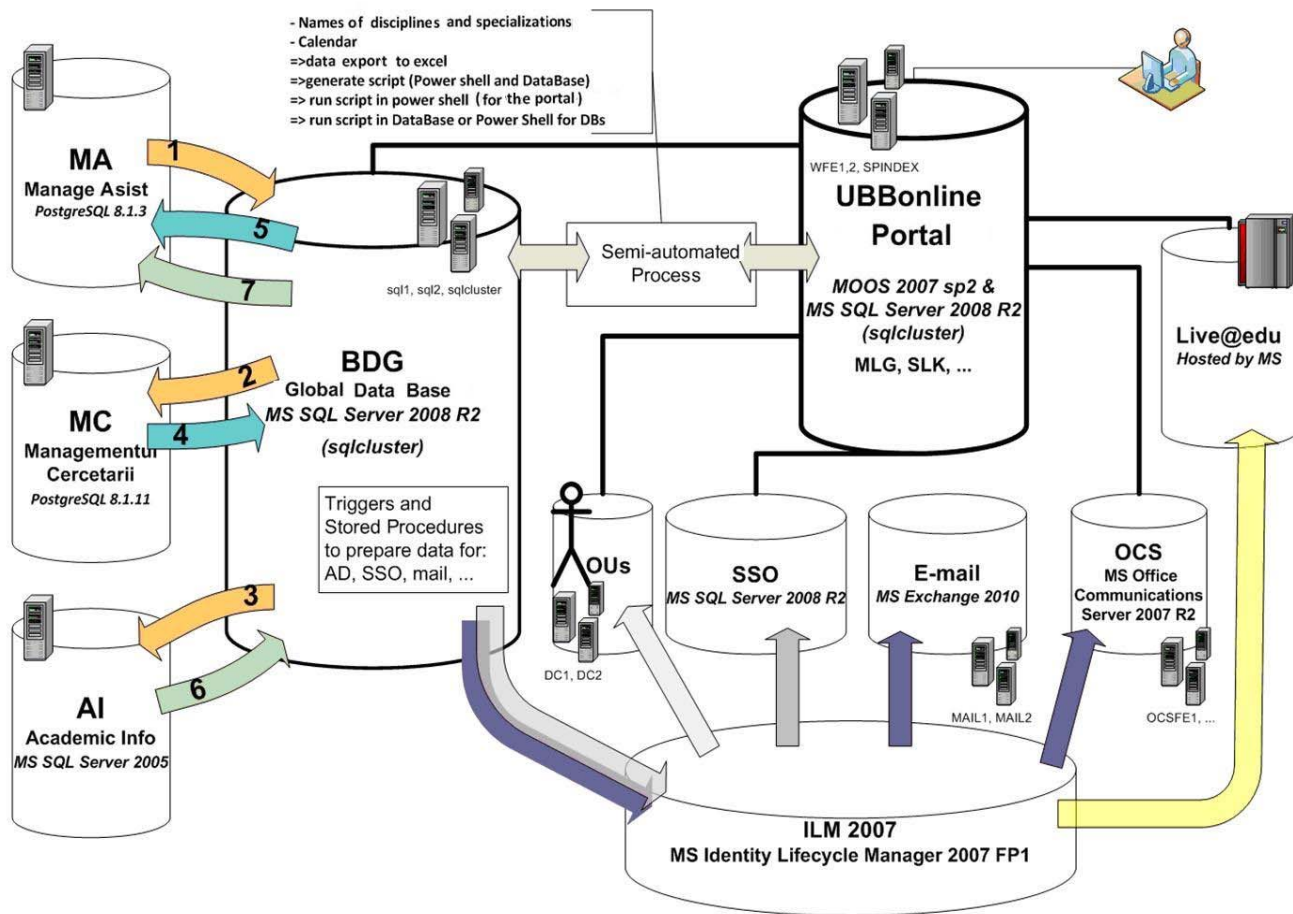


Figure 2. Portal global architecture.

III. THE WEB SERVICES

We further describe the web services provided by UBBonline e-learning portal [24].

A. E-learning functionalities and virtual labs

The implementation of e-learning facilities strongly contributed to the development of the student and goal centered learning model [1]. E-learning facilities are usually provided by means of web services.

The web-based e-learning facilities provided by the described portal are the SharePoint [18] built in ones, adapted to our specific needs, and include:

- ◇ content management and sharing (see Fig. 3);

- ◇ schedule management and sharing,
- ◇ communication facilities (e-mail – OWA type, discussion lists, etc.),
- ◇ evaluation tools and feed-back facilities;
- ◇ task management, blog and RSS tools,
- ◇ survey tools, as well as other functionalities.

The system is also open to adding new web-parts, services or components (for example, evaluation ones are being developed). **Virtual lab services** enable modelling of processes that may be tedious to be accessed in real conditions, or are required to be accessed remotely. These facilities support learning in experimental sciences and sharing experimental knowledge by electronic means in: process engineering, environmental engineering, physics,

chemistry, biology, etc. Our virtual labs facilities refer to: on-line virtual experiments and on-line labs; case studies based on mathematical modelling and simulation; recorded video sequences and on-line video streaming; posting material to be further processed with dedicated clients. Besides facilities for publishing virtual lab educational

content within the discipline's media library, the portal includes tools for managing virtual lab resources, modelled as a workflow for requesting, approving and allocating specific resources, like videoconferencing facilities, virtual machines, specific experimental equipments, etc.



Figure 3. Managing an educational resource (in design permissions).

B. Dedicated services provided by the information systems

AcademicInfo [21] is an integrated information system dedicated to managing educational information, with facilities for secretariats, specific access for students and teachers and relevant syntheses on the educational process. The system models educational processes at BBU level, ensuring course selection in all faculties' curricula, models in a flexible manner various types of educational activities (BA, MA, PhD, continuous), ensures multilingual support in processing & reporting. Specific web services are dedicated to: *students, teachers, academic management* – see also [7].

ManageAsist system is the integrated software system for administrative management that has been developed for our university. The system can be viewed as an ERP (Enterprise Resource Planning) system; in its design and implementation, we integrated systematic efficiency principles in software design [4]. ManageAsist's principles and facilities are adapted to high education institutions, containing: Document management, Assets, Warehouse, Cashier, Finance, Accountancy, Grants, Human Resources and Acquisitions modules, decision assistance facilities [4]. Each module contains management reports for the corresponding compartment. Relevant synthesis from each compartment will be integrated, together with global

management tools into a decision support module. The web services [22] include access to grant financial information and management of acquisition request, including specific reporting facilities for management levels.

Our **Research Management System** [23] is a web based system that we have developed and implemented within Babes-Bolyai University (BBU) in order to manage research activities. The system offers, via web interfaces, accessible and user-friendly means of collecting specific information, and automatically performing quantitative analyses, syntheses and evaluations based on the collected information. The system is a tool for quantitative research evaluation, ensuring proficient management of BBU research activity and supporting competitive strategies in the field [2].

C. Authentication Characteristics

The portal provides single sign-on [29] facilities using a MS ILM - Identity Lifecycle Management Server [26] and ISA Server; the authentication is based on Active Directory facilities [6]. While OpenAuth protocol [27] grants access without sharing passwords, the architecture we describe uses the ILM facilities for synchronizing authentication information (User, password), according to [26]. This credential exchange is similar to the one used by OpenID protocol [28], but is performed by means of the ILM built in

facilities, according to [26]. The authentication mechanism also implements the MS Domain Trust policy [25].

We consider that the architecture based on ILM server [26] has good implementation advantages, since it already provides built-in web authentication facilities [6].

D. Extensibility principles

The solution we propose, based on MS technology and ILM authentication server, may be applied in various cases that require information system integration. Moreover, such an architecture may be enhanced with SharePoint facilities in order to provide sharing, communication and e-learning functionalities, which are often necessary within organizations. Considering we have available n information systems, the software services that can be provided into the web portal are represented in Fig. 4.

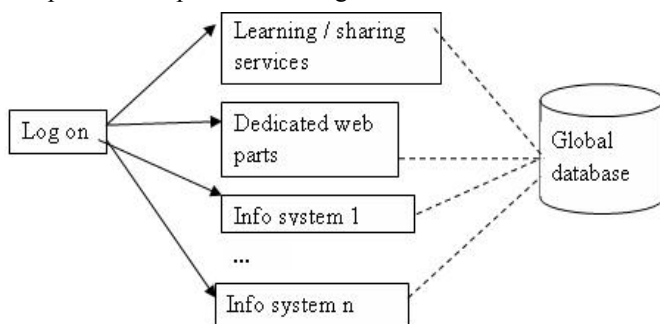


Figure 4. Web portal services.

IV. SERVICES ON-DEMAND

Within the trend of providing proficient on-demand services, we have designed an extended portal architecture in order to include on-demand cloud services. This architecture is based on the integration of MS Office 365 [31], which offers cloud services solution for mail, office applications and collaboration tools. Presently, Live@edu's facilities (initially used for student accounts) have been migrated into Office 365. Office 365 integrates various product facilities within one, on-line tool [31]: office applications streamed from the cloud in real time, access to e-mail and calendar from any location (personal computer, web access, mobile or smart device), professional web sites facilities, file sharing and project management facilities, instant messaging, presence and conferencing, mobility, security and trust.

Authentication integration and single sign on are performed based on the principles used in the initial architecture – see Section 2, by using Forefront Identity Manager and Exchange web functionalities are used for hosted e-mail accounts. E-mail migration is performed using the dedicated tools both for e-mail accounts [33] and office features [34], and pursuing the specific stages.

Cloud services have important on-demand availability characteristics, on an externally hosted infrastructure, and convenient costs (for example, in the case of student e-mail and file accounts, an owner hardware infrastructure would be more expensive). The use of such facilities may be extended with Office on-line functionalities.

Universities' usage of cloud services, with important benefits cost/proficiency benefits for large numbers of students are to be taken into consideration. E-mail, file space and Office facilities are relevant in this respect. The experience, including the information system integration principles proposed in Section 3D, may be transferred to other organizations with learning goals or with large numbers of employees, especially in the case of initially scarce infrastructure investments.

After fully implementing these facilities, we plan to compare access time and workload for the on-site and in-cloud scenarios and to perform a complete cost-benefit analysis.

V. CONCLUSION AND FUTURE WORK

The paper describes the evolution of portal architectures from web services to cloud services. The current portal architecture provides system integration facilities, systems being integrated, together with sharing and communication facilities into a global portal.

Our case study is performed on an academic institution; the universities' case is quite complex, since their activity covers: education, research, administration. The system framework integrates various web services within the portal: e-learning facilities, virtual labs and dedicated information facilities. We describe the integration solution of web services into the portal, including web-based facilities from the dedicated information systems. The solution is based on MS technology and provides means of integrating various information systems by implementing a single authentication server and mapping specific facilities from the dedicated information systems, for each user category. This architecture is based on a global integrated database and a permission mapping scheme for ensuring appropriate access into the dedicated information systems.

Synchronization processes from the information system databases into the global database run daily, taking up to 30 minutes or less, depending on the database updates, for a ~50GB global database. Single sign-on permissions are also updated daily based on data provisioned by the dedicated systems. This web service integration solution has a good extensibility degree and may be applied in various organizational cases, aiming at providing integrated services, by building a single log-on framework for learning, collaboration facilities, and integrating dedicated information system services.

On a second development stage, we have extended the portal architecture with on-demand cloud services taking into account their high availability and convenient costs. Therefore, students use Office 365 facilities for e-mail and file space facilities. This solution has important advantages regarding necessary storage space, which is externalized, as well as the necessary software services, which are provided in the cloud. After fully implementing these facilities, we plan to compare access time and workload for the on-site and in-cloud scenarios.

The advantages of the proposed solution rely in providing a uniform web framework for: database synchronization of various information systems databases

and web access to e-learning and information collaboration & sharing tools and dedicated system facilities. The proposed framework enables data and service integration – both web and cloud – that are available at with single sign-on. This integration solution has a good extensibility degree and may be applied in various cases.

ACKNOWLEDGMENT

The work described in this paper was supported during 2009-2011 by the EU funded grant, within the European Fund for Regional Development, “CCE 124/323/31.08.2009 SMIS 4424 - Sistem electronic aplicativ integrat de educatie al Universitatii Babes-Bolyai” – Integrated applied electronic system for education of Babes-Bolyai University - BBU, contracted by BBU with the Romanian Ministry of Communication and Information Society, Organismul Intermediar pentru Promovarea Societatii Informatiionale (the Intermediary Structure for Promoting the Information Society), during 31-08-2009 – 31-08-2011

We thank to the whole development team in our IT department for their contribution to developing ManageAsist, AcademicInfo, Research management information systems and to administering the e-learning portal: F. Tufiş, C. Miu, S. Nemeş, D. Pop, M. Bojan, C. Pavel, A. Iuhos, A. Bara, Kerekes H., Zölde A., Kerekes T.

REFERENCES

- [1] M. Allen, Guide to e-Learning. Wiley, 2002
- [2] A. B. Andreica and P. S. Agachi, “Design and Implementation of An Integrated Software System for Managing Research Activities in Universities”, 7th RoEduNet International Conference - Networking for Research and Education, UT Press, Ed: E. Cebuc, Cluj-Napoca, Romania, pp. 90-95, 2008
- [3] A. B. Andreica, IT Management, EFES, Cluj-Napoca, 2009
- [4] A. B. Andreica, D. Stuparu, and F. Ghetie, “Design and Implementation of an Erp System for Universities”, Proceedings of Information Systems 2009, IADIS, Barcelona, Spain, Eds: M. Nunes, P. Isaias, P. Powell, pp. 315-322, 2009
- [5] A. B. Andreica, F. Covaci, D. Stuparu, and G. Pop, “An E-Learning Web Portal with System Integration Facilities”, Web Information Systems and Technologies 2010, Valencia, Spain, Proceedings of 6th International Conference WEBIST, I, INSTICC, Ed: J. Filipe, J. Cordeiro, 2010, pp. 131-136
- [6] A. B. Andreica, F. Ghetie, D. Stuparu, I. Arpad, and G. Pop, “Integrated E-Learning Web Services”, 4th International Conference on Mobile Ubiquitous Computing, Systems, Services and Technologies, Florence, Italy, UBICOMM 2010 Proceedings CD, IARIA, Ed: J. Lloret Mauri, S. Baladin, C. Dini, 2010, pp. 0-5
- [7] A. B. Andreica, D. Stuparu, F. Ghetie, and G. Pop, “An Integrated Software Solution for E-learning and Academic Services”, International Technology, Education and Development Conference 2011, Valencia, Spain, 7-9 March 2011, IATED Proceedings CD , IATED, 2011, pp. 1-8
- [8] A. B. Andreica, D. Stuparu, R. Gadi, F. Covaci, C. Tarta, G. Marcus, G. Pop, and O. Teodorescu, “Design and Implementaiton of An Integrated Web Service Architecture”, Web Information Systems and Technologies - Web Services Principles and Applications, Noordwijkerhout, Holland, 6-9 May 2011, Proceedings of WEBIST 2011, Ed: J. Filipe, Jose Cordeiro, pp. 631-637
- [9] A. B. Andreica, D. Stuparu, F. Covaci, C. Miu, G. Pop, Gadi R., F. Chira, G. Marcus, C. Tarta, and C. Campeanu, “An Integrated Web Architecture for Providing Academic Services”, IADIS International Conference E-learning 2012, IADIS MCSIS 2012, Lisbon, Portugal, Ed: M. Batista Nunes, M. McPherson, 2012, pp. 449-454
- [10] E. Gamma, R. Helm, R. Johnson, and J. Vlissides, Design Patterns, Teora, 2002
- [11] M. T. Goodrich, R. Tamassia, D. Yao, “Notarized Federated Identity Management for Web Services” <http://www.cs.brown.edu/cgc/stms/papers/notarizedFIM.pdf>, accessed July 2011
- [12] W. Hasselbring, “Information System Integration”. Communications of the ACM, 43 (6) , 2000. pp. 32-36
- [13] W. Hasselbring, S. Pedersen, “Metamodelling of Domain-Specific Standards for Semantic Interoperability”. Lecture Notes in Computer Science, 3782, 2005, pp. 557 – 559
- [14] W. Horton and K. Horton, E-learning Tools and Technologies: A consumer's guide for trainers, teachers, educators, and instructional designers, Wiley, 2003
- [15] D. Stuparu, A. Andreica, and I. Mantu, “Comparing Access Techniques on Databases in Distributed Application Frameworks”, Proc. of Collaborative Support Systems in Business and Education, BBU, Cluj-Napoca, 2005, pp. 1-10
- [16] J. Shaw, “Unified and Intelligent Identity and Access Management”, Quest Software, White Paper, 2011
- [17] R. Webster and F. Sudweeks, “Teaching for e-Learning in the Knowledge Society: Promoting Conceptual Change, in Academics’ Approaches to Teaching”, Current Developments in Technology-Assisted Education, 2006, <http://www.formatex.org/micte2006/pdf/631-635.pdf> [retrieved: 7, 2011]
- [18] MS Learning Gateway and SharePoint Portal, <http://www.microsoft.com/education/solutions/higheredportals.aspx> [retrieved: 6, 2011]
- [19] PostgreSQL Team, “High Availability, Load Balancing, and Replication”, <http://www.postgresql.org/docs/8.3/static/high-availability.html> [retrieved: 7, 2011]
- [20] Business Explorer for Web Services, <http://www.alphaworks.ibm.com/tech/be4ws> , accessed July 2010
- [21] BBU AcademicInfo System, <http://academicinfo.ubbcluj.ro/Info> [retrieved: 7, 2011]
- [22] BBU ManageAsist System, <http://manageasist.ubbcluj.ro> [retrieved: 7, 2011]
- [23] BBU Research Management System, <http://infocercetare.ubbcluj.ro> , [retrieved: 7, 2011]
- [24] BBU E-learning portal, <https://portal.portalid.ubbcluj.ro> [retrieved: 7, 2011]
- [25] Federated Identity Patterns in a Service-Oriented World, <http://msdn.microsoft.com/en-us/architecture/cc836393.aspx> [retrieved: 7, 2011]
- [26] Identity Lifecycle Management Server, <http://www.microsoft.com/windowsserver2003/technologies/idm/ilm.msp> [retrieved: 7, 2011]
- [27] OAuth protocol, <http://oauth.net/> [retrieved: 7, 2011]
- [28] OpenID protocol, <http://openid.net/> [retrieved: 7, 2011]
- [29] SingleSignOn, <http://www.authenticationworld.com/> [retrieved: 7, 2011]
- [30] Web Services Federation Language, Dec 2006, BEA Systems, IBM Corporation, Layer 7 Technologies, <http://www.ibm.com/developerworks/library/specification/ws-fed/> [retrieved: 7, 2011]
- [31] MS Office 365, <http://www.microsoft.com/en-us/office365/what-is-office365.aspx> [retrieved: 11, 2012]
- [32] Oracle Users Group, http://education.oracle.com/web_prod-plot/plsql/ou_usergroups.ou_ioug_home [retrieved: 12, 2012]
- [33] MS Exchange Deployment to Office 365, <http://help.outlook.com/en-us/exchangelabshelp/ff633682> [retrieved: 12, 2012]
- [34] MS Office 365 Migration, http://www.microsoft.com/government/en-us/products/office/365/how_to/Pages/default.aspx [retrieved: 12, 2012]