The Fourth International Conference on e-Learning (eLearning-2013), 26-27 September 2013, Belgrade, Serbia

MODELING UNIVERSITY METROPOLITAN ONLINE LEARNING SYSTEM ARCHITECTURE - THE TOGAF/ ARCHIMATE WAY

SVETLANA CVETANOVIĆ
Belgrade Metropolitan University, Faculty Of Information Technology, svetlana.cvetanovic@metropolitan.ac

DUSAN VELJKOVIC
Qficient, Inc. dveljkovic@qficient.com

BOBAN NIKOLIC
IRVAS International d.o.o. boban.nikolic@irvas.rs

DRAGAN DOMAZET
Belgrade Metropolitan University, Faculty Of Information Technology, dragan.domazet@metropolitan.ac

Abstract: *BMU as a complex business system has to be considered as an enterprise when it comes to the strategic planning and implementation of the IT system. In this paper we are focusing on the architecture of the university's main business subsystem which supports online learning. The goal is to envision and detail; elements of the enterprise architecture . In order to satisfy variety of the stake holders' viewpoints it is necessary to develop and communicate findings in the form of visually rich and easy to understand architectural view artifacts. We took approach to combine TOGAF framework as a methodology and ArchiMate as a language and communicate deliverables in a standardized manner. The current snapshot of the BMU Enterprise Architecture development cycle is taken and shown by the most representative diagrams. The main features of the two Open Group standards are presented as an introduction.*
Keywords: *Enterprise Architecture, E-Learning, Learning objects, TOGAF, ArciMate*

1. INTRODUCTION

Today, the business of any modern enterprise cannot be imagined without the use of IT. In order to support local customer demands and market regulations and respond to competitor challenges and market opportunities, enterprises use complex information systems. But, with a continuous addition of new applications that support new or modified business process, retention of legacy platforms and a growing the need for integration with a number of other environment systems, the enterprise IT landscape has reached a remarkable level of complexity. On the other hand, enterprise must have a clear, integrated vision on the relation between its business and IT. Without such a vision, the IT infrastructure will never adequately support the business, and vice versa, the business will not optimally profit from IT developments.

In order to control IT complexity and achieve alignment between business and IT, an integrated approach to all aspects of the enterprise is required. Organizational effectiveness is not obtained by local optimizations, it must be realized by well-orchestrated interaction of organizational components. Bernus at al.[6] defines enterprise architecture (EA) as a coherent whole of principles, methods and models that are used in the design and realization of the enterprise's organizational structure, business processes, information systems, and infrastructure [1]. The other definitions of EA is done by Bente at al. [2] who say that EA provides guidance about what technologies are a strategic fit, which ones are deprecated, and which are emerging. [1]

With the emergence of the EA concept, the concept of EA frameworks also arises. Bente at al. [2] defines an EA framework as a set of assumptions, concepts, values, and practices that constitutes a way of looking at enterprise reality via views or (architectural) models. Similarly, Lankhorst et al. [4] define a framework as a mean to provide structure to the architectural descriptions by identifying different architectural domains and the modeling techniques associated with them. The true number of EA frameworks depends on what you count as a "framework", but there is definitely an abundance of them. In this paper we focus on TOGAF framework.

According to Bente at al. [2] the holistic view of the enterprise's IT requires more than one architectural perspective to cover all aspects, primarily we are looking at

- Business architecture that is concerned about the business goals, organizational units, geographical locations, processes, entities of the business realm.
- Infrastructure architecture, consisting of servers, networks, data stores, software products, standards, frameworks, and further miscellaneous hardware and software thingies of which a runtime environment is composed.

[1] This paper provides some results obrained by the project with code III44006 financed by the Ministry of Education, Science and Technological Development of Rebublic of Serbia

In practice these architectures are not approached in an integrated way. Every architecture speaks its own language, draws its own models and uses its own techniques and tools. Communication and decision making across architectures is seriously impaired. To create an integrated perspective on enterprise architecture, one needs both: a description technique (modeling languages) for these architectures, and EA framework in which this technique and methodology is employed.

In this paper, the experiences in building EA architecture models by applying EA framework and modeling language, exhibited in a number of papers, are used. The authors being taught by these experiences, especially those that address the joint of TOGAF framework and ArchiMate language, try to present the Metropolitan University integrated architecture, with a special emphasis on its e-learning system.

This paper is organized as follows: Section 2 describes TOGAF *Version 8.1.1* [7] and ArchiMate [8] as a way of presentation Metropolitan University EA in integrated way. Section 3. demonstrates the implementation of these two standards in this particular case. Section 4 concludes the paper.

EA FRAMEWORK AND MODELING LANGUAGE AS A WAY TO MODEL INTEGRATED EA

As mentioned above, there are many EA frameworks, but two of them are referred in this paper.

- Zachman's "framework for enterprise architecture" because it is one of the first explorations in EA
- The Open Group Architecture Framework (TOGAF *Version* 9.1,) since it is an open EA framework, that means that TOGAF is industry-agnostic, vendor-neutral, and community-based

The Zachman framework is widely known and used. The Zachman identifies 36 views on architecture ("cells"), based on six levels (scope, enterprise, logical system, technology, detailed representations and functioning enterprise) and six aspects (data, function, network, people, time, motivation). Each cell represents one and only one aspect of an enterprise and each of those aspects is represented with a stand-alone model. In essence, the Zachman Framework is simply a framework of EA elements. [6].

TOGAF is a generic yet comprehensive methodological framework for developing enterprise architectures. It is owned by The Open Group consortium and free for your own use within the enterprise [7]. TOGAF is completely incorporated in the TOGAF Architecture Development Method (ADM) which is consisted of a stepwise cyclic iterative approach for the development of the enterprise architecture. The framework considers an overall EA as composition of closely interrelated views, which are to be modeled:

- Business Architecture Views,
- Information Systems Architecture views, comprising Data Architecture views and Applications Architecture views,
- Technology Architecture views and
- Composite views.

TOGAF Framework does indeed identify relevant architecture building blocks, but the problem is that it does not constitute a precisely defined language, nor does it provide a notation for these building blocks and their integration [7]. TOGAF does not contain guidance on creating a consistent overall model of the architecture. On the other hand, the methods and techniques used to document the architectures are heterogeneous and it is very difficult to determine how the different domains are interrelated.

In order to solve these problems and create an integrated perspective on enterprise architecture, one needs: (1) EA framework by witch appropriated views can be identified (2) modeling languages that can describe element within these views and relationships between them. The primary focus of modeling language for enterprise architectures should be on inter-domain relations. With such a language, it should be able to model both the global structure within each domain, showing the main elements and their dependencies, and the relations between the domains, in a way that is easy to understand for non-experts. Lankhorst et al., [4] in his paper presented the marriage between these two elements: the enterprise modeling language ArchiMate and TOGAF. These two standards complement each other: TOGAF provides an elaborate method, including a process, guidelines and techniques, for enterprise architecture development, while ArchiMate provides a well-defined language, including a graphical notation, for enterprise architecture modeling. ArchiMate complements TOGAF by defining a fully worked out (graphical) modeling language, including the definition of relevant viewpoints. Together, these two standards make up a complete and integrated approach to enterprise architecture.

The Open Group considers that the central role in ArchiMate plays the service concept [8]. The service concept represents a unit of essential functionality that a system exposes to its environment. For the external users, only this external functionality, together with non-functional aspects are relevant. By using service concept, language can provide well-defined relationships between concepts in different architectures that may be done using other, standard or proprietary modeling languages. Concepts in the ArchiMate language currently cover the business, application and technology layers of an enterprise. Services offered by one layer to another play an important role in relating the layers. The role of ArchiMate in integrated EA is shown in figure 1.

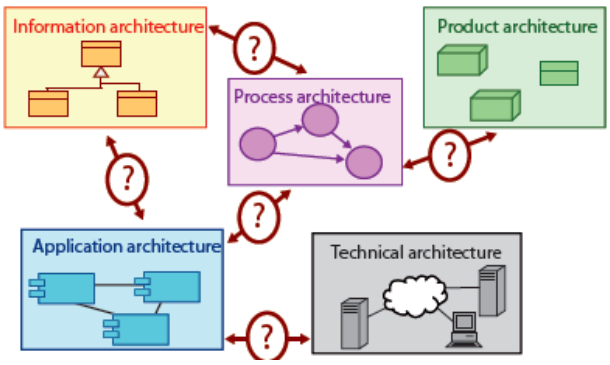

Figure 1: Integration of Architectural Domains by ArchiMate

Jonkers et al., note that ArchiMate has core and extended elements [3]. The ArchiMate core defines the concepts to model actual architectures, as described in Phases B, C and D of the TOGAF ADM. This is essentially the part of ArchiMate as described in Version 1.0. ArchiMate 2.0 provides two extensions for this: one for describing motivation (e.g. stakeholders, goals and requirements), and one for implementation and migration planning. In this paper we are focuses on core elements and two extensions are not the subject of our work.

Figure 2. shows a global mapping of the ArchiMate framework (core and extensions) to the phases of the TOGAF ADM.

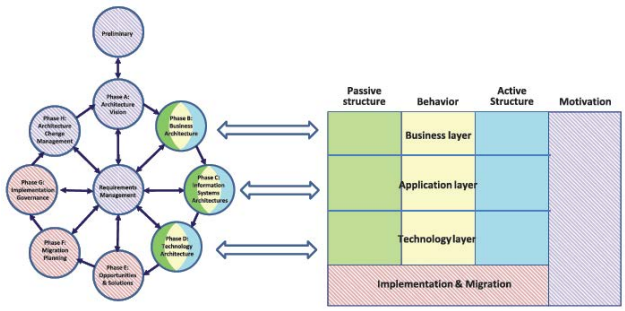

Figure 2. TOGAF ADM and ArchiMate [8]

Within each layer, defined by TOGAF ADM (the business layer, the application layer including data layer, and the infrastructure layer) three aspects are described: the active structure, i.e., the entities that perform behavior (e.g., business actors, application components, infrastructure nodes), the behavior (e.g., processes, functions, and services), and the passive structure, i.e., the (information) objects that are processed as part of the behavior.

IMPLEMENTATION OF TOGAF AND ARCHIMATE IN THE METROPOLITAN UNIVERSITY EA

University Metropolitan is a complex enterprise that supports business processes related to the online and traditional learning and many other functions that are specific to private educational university such as human resources, finance and accounting, students' services, marketing and so on. Information system that now supports these business processes are: E-learning system (realized by Oracle), Students' service system (internally known as ISUM – University Metropolitan information system, also implemented by Oracle RDBMS), Document Management System (Alfresco) and Workflow Management System (Bonita). Given the complexity of business processes as well as a large number of systems currently in use, University Metropolitan's management decided that, before the implementation of the new information system, enterprise IT architecture should be done.

University Metropolitan EA results should convince the University management that IT systems will support the ways of doing business at University, achieve its strategic objectives and act as a strategic foundation for business enablement. Given that University Metropolitan is enterprise whose goal is education, its strategy is primary related to modernize and improve the quality of education by providing students better access to contents and knowledge needed to complete their study and an easier way to teach the learning material required for appropriate study programs. This is the way that the University increases the number of graduating students, decrease the average duration of studies for students in the participating academic programs and achieves better profits.

The entire University Metropolitan IT architecture is under construction, but since the improvement of the quality of distance learning is primary strategic goal of the University, our first priority focus is to present in this paper architectural services relating only to e-learning system.

The goal of e-learning system is to allow creation of instructional materials needed for each student for successful studying. The system has to provide functionalities of creation and presentation of needed e-learning contents, i.e. the needed instructional material, specifically created for each student. System aims to implement e-learning methodology and technology based on learning objects (LO) created according to the specified Body of knowledge for each program. These LOs will be stored in a repository and will be used when needed to configure one or more courses or lesson for each student. In accordance with the chosen knowledge level of a student, the personalized e-learning system will select needed LOs from the repository. In order to be able to support sustainable personalized learning system, a repository of multimedia LOs, which are flexible to various sequencing, needs to be developed. The sequencing of LOs will allow more effective organization, presentation and search of learning content.

In order to build architecture of such e-learning system, business roles, business functions and business processes should be identified first. A business role has responsibility for one or more business processes or business functions. A business function denotes the high-level capabilities of an organization, and offers

functionality that may be used in business processes to realize the e-learning services of the University.

For the sake of simplicity the mission critical roles and actors are identified only and depicted by the Figure 3.

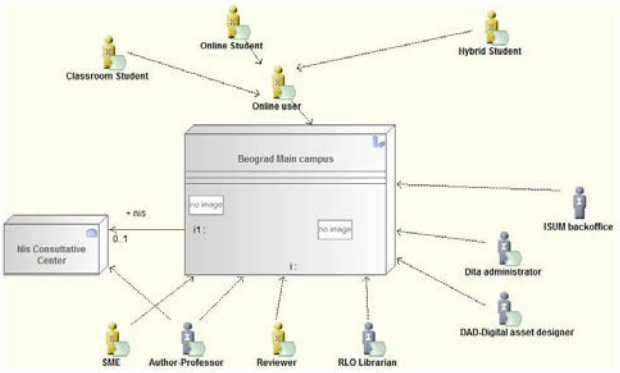

Figure 3. Business roles and actors in e-learning system architecture

"Online User" role aggregates different types of BMU student actors and has access to the published e-learning courses and content,. Other actors needed access to the online content could be added to aggregation.

"Author – Professor" role integrates two main authoring functions, first content creation in the form of reusable learning objects and second assembly of the LO lessons and courses by applying instructional design rules and techniques.

"Reviewer" can include translator and lector, is mandatory role which is to ensure good quality content production.

IT department provides support for the technical structural writing and multimedia Digital asset development through DITA Administrator and DAD-Digital Asset Designer. Separate admin role of " RLO Librarian" is responsible for the reusable learning object repository management including search ability through the keywords and metadata standardization.

"ISUM Back-office" actor represents non e-learning internal subsystem managing student affairs, accounting, financing…

The following business processes are of particular interest in e-learning system:

- Authoring LO (build multimedia content of learning objects and enter them in LO Repository)
- Instructional design (Sequencing of learning objects)
- Online learning

Authoring LO as a process creates set of learning content components and assemble them into Learning Objects (LO). For this purpose DITA framework for structural writing is used to capture and organize content into XML components. LO are conceptualized based on Body of knowledge for each study program. Body of knowledge is further subdivided into topics. Topics are the lowest level of the hierarchy according to the curriculum guidelines. In order to be able to implement model where the smallest units are learning objects, we have further divided each topic into a subtopic, and when needed, we have divided subtopics into learning objects. For each LO content should be created. These LOs will be entered and stored in a repository and will be used when needed to configure one or more lessons for students.

Instructional design phase comes to the scene once all content of learning objects are defined. We can then proceed with the definition of learning object sequences. LO sequencing allows that LO reusability e.g. that they can be incorporate into different lessons or courses. The LO reusability provides easy capability of adapting materials for personalized learning needs.

Online learning means appearance of learning objects in appropriated forms for students and other online learners.

In the Figure 4., one of the Authoring LO sub processes is detailed representing one of the most critical part – "DITA topic creation". Business processes are described by using BPM languages for business process modeling.

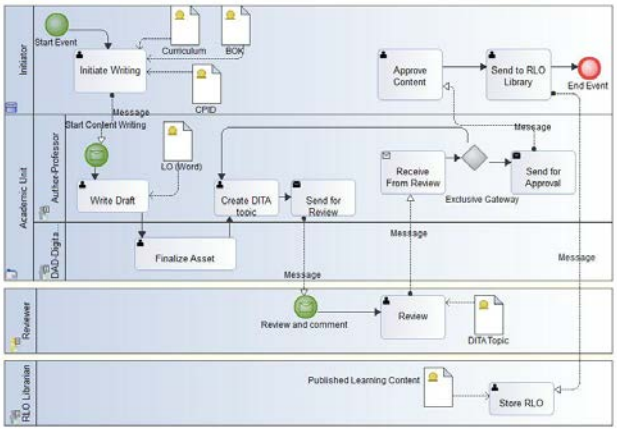

Figure 4. LO DITA topic creation sub process

The following figure 5. represents high level process of Instructional design which produces lessons and courses as a deliverable ready to be consumed by online users. Initiative to build new lesson / course triggers fundamentally two sub activities, first content creation based on BOK (body of knowledge) and described in the CPID (content project initiation document). Result will be set of RLO (Reusable Learning Object) stored in the RLO Library.. Instructional designer will select and assembly appropriate RLOs by adding LA (Learning Activities) and organizing their instructional flow. Ultimately finished lesson/course sequence will be published into the LMS (Learning Management System) for the student consumption.

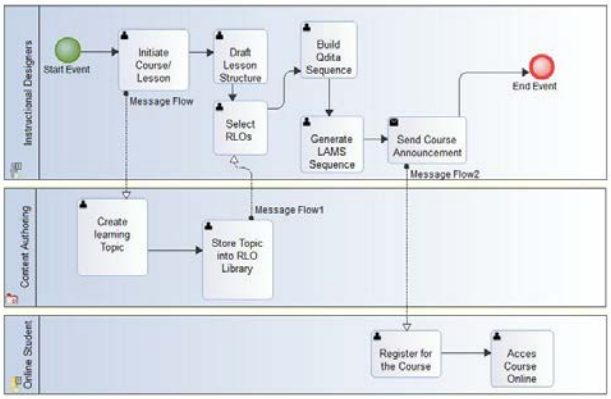

Figure 5. Instruction design

Example of integrated and service-oriented e-learning system architecture is represented in figure 6. It was constructed by connecting models from different (business, application and technology) layers, by means of services.

Business layer model is done based on information gathered during the analysis of business processes within the University. The external behavior of a business process is modeled by the business service ("Authoring LO", "Instruction design", "Online learning and admin") which represents meaningful functionalities from the point of view of the environment (roles and users).

The main concept for the application layer is the application component that is used to model reusable software components that can be part of one or more applications or complete software applications and information systems. The application layer supports the business layer with application services "Authoring structured contents", "Authoring learning sequences" and "Learning management" which are realized by software application components QDITA (Qficient Darwin Information Typing Architecture) and LAMS (Learning Activity Management System).

In each of these two software component, application functions that realize their internal behavior are shown. For example, software component QDITA is realized by functions "Authoring QDita learning content", "Authoring QDita learning objects", "Authoring QDita learning sequences" and "Publishing". Software component LAMS is built by application functions "Authoring LAMS learning sequences" and "Authoring on line courses".

Information models in the case of e-learning system are not based only on relational databases, which are commonly used in practice. The data architecture takes in account concept of the documents as architectural entity and was presented by using global entities such as "Learning topic", "Sequential maps", "RLO repository" and "Sequence Store". Those are parts of "Qdita source store" and "RO library" compositions. They are realized by Alfresco ECMS (Enterprise Content management system) software component, whose services are visible only to application layer. "Online lesson" and "Learning activities" are two additional entities that construct "LAMS data objects" data composition, realized by MySql RDBMS and visible only to application layer.

The main structural concept for the technology layer is the node that is used to model physical computational resource and system software that represents the software environment for specific types of components and data objects. Infrastructural services offered by a node can be accessed by other nodes or by application components from the application layer. In the case of University Metropolitan, there are three servers and each of them has a special purpose. The first server is responsible for hosting the QDITA, Activiti WfMS (workflow management system) and Alfresco ECMS and as a link to the Application layer it offers QDITA services including the most important CMIS service. The second server is responsible for hosting the LAMS application and it is visible by LAMS service. The third server is responsible for the user management whose services are used internally by the first two servers through LAN node.

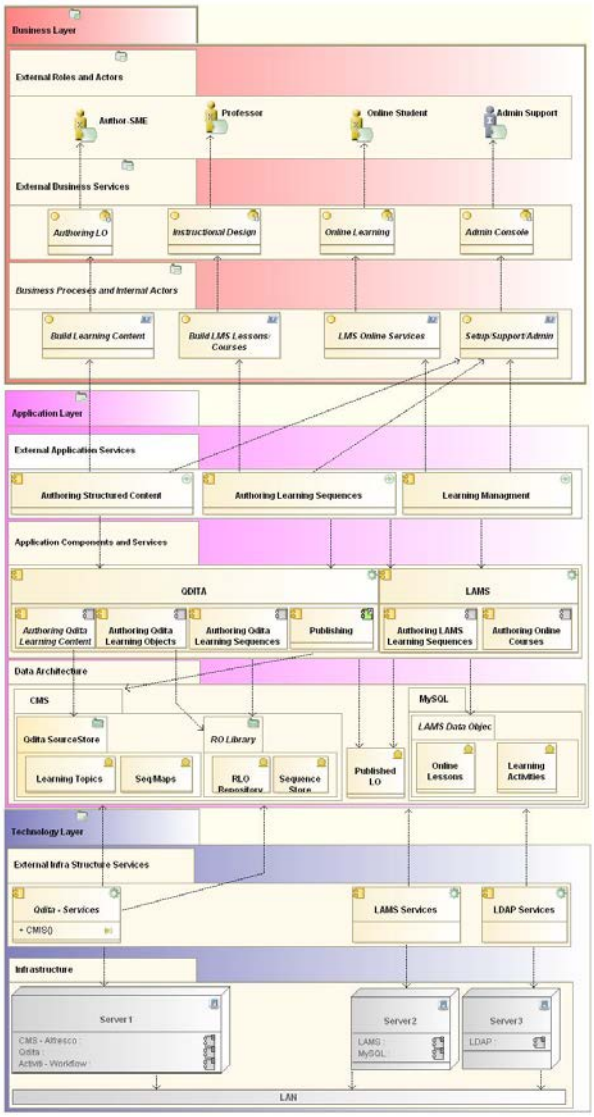

Figure 6. E-learning system architecture

CONCLUSION

TOGAF and ArchiMate provide complete modeling support throughout the architecture development cycle. They complement each other with respect to the definition of an architecture development process and the definition of an enterprise architecture modeling language. TOGAF identifies relevant architecture views, but it does not provide a notation for these views and their integration. It is done by ArchiMate which primary role for enterprise architectures is inter-domain relations.

The authors of this paper, tried to construct the overall University Metropolitan Enterprise architecture, by using experiences of those that address the joint of TOGAF and ArchiMate. But the architecture development is very complex and long-term process that should be performed by applying agile principles and concepts. In this paper, we presented the result of first iteration which is focused on e-learning system architecture. Here, one of the architecture snapshot is shown, but the work is ongoing and in the next iterations, BMU EA should be further developed and elaborated.

LITERATURE

[1] P. Bernus, L. Nemes, G. Schmidt. *Handbook on Enterprise Architecture*, Springer, 2003.

[2] S. Bente, U. Bombosch, Sh. Langade, *Collaborative Enterprise Architecture: Enriching EA with Lean, Agile, and Enterprise 2.0 Practices, 2013*

[3] H. Jonkers H., D. Quartel, B. Gils and H. Franken, *Enterprise Architecture with TOGAF® 9.1 and ArchiMate® 2.01*

[4] M. Lankhorst, H. Drunen, *Enterprise Architecture Development and Modelling Combining TOGAF and ArchiMate*, 2007

[5] D.A. Nadler, M.S. Gerstein & R.B. Shaw. *Organizational Architecture:Designs for Changing Organizations*. San Francisco. Jossey-Bass Publishers, 1992.

[6] J.F. Sowa & J.A. Zachman. Extending and Formalizing the Framework for Information Systems Architecture, IBM Systems Journal, 31(3):590-616, 1992.

[7] TOGAF® Version 9.1, Van Haren Publishing, 2011. Also available on http://www.togaf.org

[8] ArchiMate® 2.0 Specification, Van Haren Publishing, 2012. Also available on http://www.archimate.org