

## A MODEL FOR INCREASING QUALITY OF EDUCATION BY USING A UNIFIED REPOSITORY AMONG BUA UNIVERSITIES

Agon MEMETI<sup>1\*</sup> , Florinda IMERI<sup>1</sup> 

<sup>1</sup> Department of Computer Sciences, FNSM, University of Tetova, North Macedonia

### Cite this article as:

Memeti, A. & Imeri, F. A model for increasing quality of education by using a unified repository among BUA universities. *Trakya University Journal of Engineering Sciences*, 21(2), 67-73.

### Highlights

- Unified repository among BUA universities
- Increase quality of education
- Reusing existing learning materials

Article Info	Abstract
<b>Article History:</b> Received: November 16, 2020 Accepted: November 28, 2020	Anyone who had to create learning materials from scratch knows how intensive and time consuming this process can be. This process can be made easier by reusing existing learning and teaching materials. Creating a unified repository enables time and effort savings, opportunities to transfer technical and technological knowledge among educational staff, exchange of practical applications experience and, most importantly, quality enhancement of educational materials. A unified repository is a web-based database application software that is used for simplifying the tasks of sharing learning contents and resources between different universities through providing a unified solution and access point. This paper proposes a model for building a unified e-learning repository system for Balkan University Association (BUA), to enable academics to store, classify, access and share teaching and learning materials, BUA resources and not only. By providing a flexible unified repository that can be adjusted to suit the diverse learning styles and necessities of students and staff, the structure proposed here can go a long way in alleviating the burden each university has to bear in terms of effort and finance.
<b>Keywords:</b> BUA; Learning materials; RESTful; Repository; Scalable.	

## 1. Introduction

The advances of internet technologies and the ICT have enabled the diversity of educational approaches for students and instructors affecting thus the increase of quality by enhancing processes, styles, and knowledge (L. Lockyer, et al, 2001).

The quality of the education process is directly affected by the quality of the learning materials. Today different software packages are used to create interactive learning objects. However, the cost to create such materials is not low, thus sharing and reusing learning objects through sharing educational repositories among different universities will help many instructors who lack resources and/or expertise to use them directly into the learning resources (J. G. Hedberg, et al, 2001).

This study aims to propose a framework, a unified repository, that implements the reuse of learning objects. Creating such a repository enables time and effort savings, increases the opportunities to transfer technical and technological knowledge among educational staff, exchange of practical applications experience and, most importantly, quality enhancement of educational materials.

A unified repository is a web-based database application software that is used for simplifying the tasks of sharing learning contents and resources between different universities through providing a unified solution and access point. Our aim is to propose a model for building a unified e-learning repository system for Balkan University Association (BUA), to enable academics to store, classify, access and share teaching and learning materials, BUA resources and not only. By providing a flexible unified repository that can be adjusted to suit the diverse learning styles and necessities of students and staff, the structure proposed here can go a long way in alleviating the burden each university has to bear in terms of effort and finance.

The paper is organized as follows: The first section deals with the introduction, the second one with unified repositories (state of practice) and the third the one proposed repository model.

## 2. Unified Repositories State of Practice

To support the idea of a unified repository different approaches are made. Learning Content Management Systems, as first efforts, fell into two categories, Centralized LCMS and Network Learning Object Repositories . Centralized LCMS were created to provide and share different readymade courses among instructors within institutions participating through that system. Such LCMS are Moodle, Blackboard, WebCT,...etc) (N. Matar, et al, 2007).

The problem with this approach was the learning object granularity and the compatibility to syllabus requirements. Many instructors were not keen on constraining teachings according to the readymade materials and they were more in favor of smaller chunks of learning objects which are related to learning requirements. Thus, the second approach, Networked Learning Object Repository is an answer to their requirements. This approach was focused in sharing learning objects, which will be used by the instructors to arrange their courses (P. Pouyioutas et al, 2005) such as LON-CAPA which stands for Learning Object Network with CAPA ([www.lon-capa.org](http://www.lon-capa.org), 2020); LIONSHARE platform, a network method for sharing resources between learners, a program that requires user authentication before using the system or sharing the resources; "SPLASH" (Richards, G, 2002), is another system that distributes learning objects repository, developed as a part of the "Portal for Online Objects in Learning" (POOL) project, a consortium of several educational private and public sector organizations whose aim was to develop an infrastructure for learning object repositories.

In April 2001, Massachusetts Institute of Technology

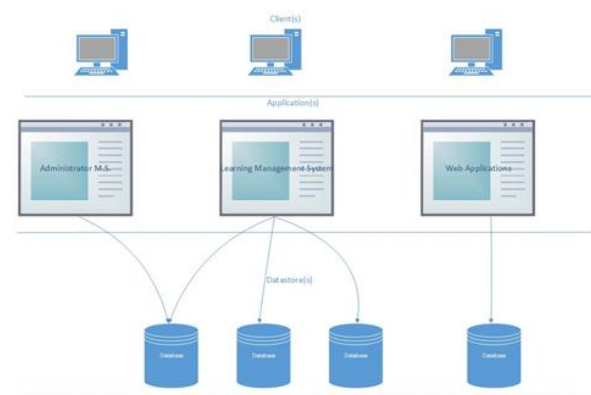
(MIT) initiated a project named “MIT Open Course Ware (MIT OCW)” to publish MIT course materials on web. 3369 Courses were published by Massachusetts Institute of Technology (MIT) till Nov. 2017. In 2005. Open Course Ware Consortium was started with aim to access the course materials over Internet and to develop online system for the publication of open course materials. The MIT OpenCourse Ware was funded and supported by the William and Flora Hewlett Foundation, the Andrew W. Mellon Foundation, and MIT (MIT, 2020).

Digital repositories enables staff and other subscribers to have easy access to scholarly and research material generated by University members; provides access to a range of materials at other institutions worldwide, where your repository forms part of a global system of interoperable repositories; provides stable, long-term archiving of information and research output thereby preserving it for the future; allows for information to be widely and quickly disseminated so that it achieves the highest impact (this can be contrasted with traditional publishing models which are based on restricting, through subscription prices, access to information) (Patel, et al, 2013).

Traditional University systems are working locally based on servers and connected externally with the internet in one location inside it, but the key problem is that Project Participants are required experienced persons taking in consideration the system administration; Depreciation of Current Technology; Organizational setting (long-linked technologies are the most and hardest to change; Resources and commitment (Computer systems, space); this would be a completely new story providing better: Mobile, decentralized and just in time learning; cost effective; speed of implementation and updating; virtualization; easy to monitor data access; latest dependency on IT department (Memeti, et al, 2-14).

### 3. Proposed Repository Model

The traditional University e-services have different web application platforms that serve to offer services to users but, they are not integrated; they are isolated in physical and business process aspects, and require specific authorization for rebuilding. In addition, the existing system has several problems such as lack of mobility, accessibility, service flexibility and portability apart from the necessity of the physical presence of the administrator to manage authorization when rebuilding applications (services) is concerned.



**Figure 1.** Existing University e-Services

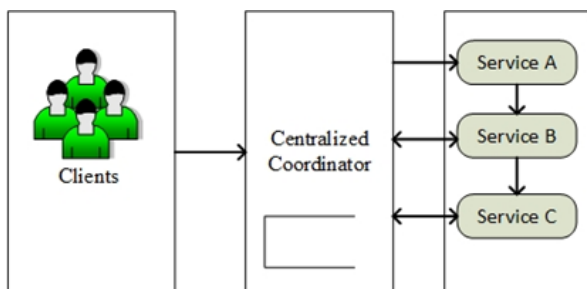
Modern SaaS applications are built on Web-based technologies and services that are highly configurable and always up to date. These key differentiators provide SaaS and its users a flexible, economical and dynamic environment in which software can be delivered where and when it is needed, and readily configured to meet specific business requirements. Modern SaaS solutions can be demonstrated, delivered and deployed rapidly, via simple, predictable and controllable subscription-based costs (Mahowald, 2009).

To form lasting and solid scientific cooperation from the past to the future, as an aim of Balkan University Association and on the other hand to preserve the stability of services, achieve an increase in the portability, reduction of complexity, failover and redundancy, there is a need to use shared repository

platform, offering flexible computational resource sharing scenarios. These computational resources are shared as a template service based on specific criteria requirements, delivering flexibility, convergence, and empowering user experience while the platform architecture design offers a scalable computational resource sharing model.

Our proposed model provides integration of all BUA University e-services by proposing a unified repository model for web-based application (services) integration. This model will reuse the existing services (applications) in the Cloud achieving reduced service (application) dependency by decoupling the authorization framework and providing integration of registered in-house services such as university Services in the Cloud. This will lead to, increasing service flexibility; preserving the stability of services (applications) and increasing portability and service (application) interoperability.

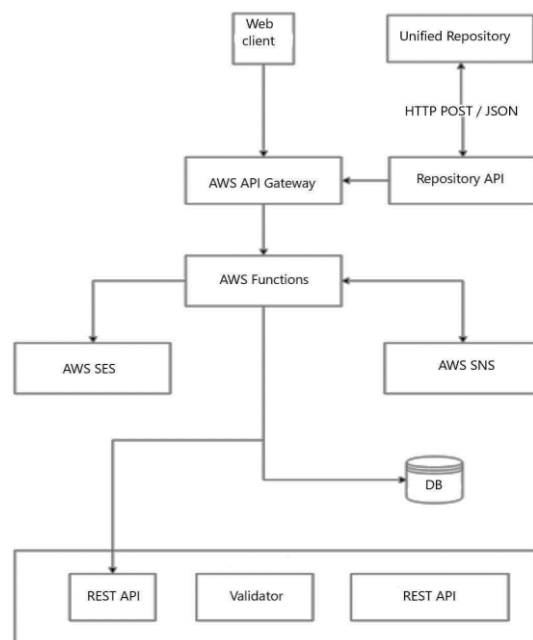
The idea behind this, is having a centralized coordinator that will maintain application keys and generate permissions as required. The coordinator will register a list of actions that each service provides. For example, given an endpoint, it provides a list of possible URL, with allowed HTTP verbs for each of them. The combination of the URL (pattern) and the verb may be used as a description of services and for specifying simple permissions. Business rules may be necessary for a more sophisticated permission system.



**Figure 2.** Centralized coordinator

Thus the idea behind this is building a U2U (University to University) platform with the aim to converge all Universities within Balkan University Association. The platform integrates with different applications and data enabling customers to use learning materials. Once a learning item/material is purchased on a University repository that has integration with our proposed platform, students after its request will be able to have it listed on their wallets.

The proposed repository (figure 3) follows the microservices approach combined with a serverless approach. One big part and the most complex of the platform is the Blockchain where on-chain data is persisted. The primary focus of this proposed platform is the integration of all Universities within BUA. This is the first integration point and it is the first step of the workflow. Based on the initial research, most of the major Universities have nonintegrated systems and to facilitate the integration we'll build client SDKs.



**Figure 3.** Architecture design of the proposed repository

To enable the integration within BUA Universities, a REST API needs to be developed that will be installed on each University's infrastructure.

The proposed platform provides webhook subscriptions that enable us to receive notifications about particular events such (seminars, online courses, etc).

The workflow is as follows:

1. Users will add to their profile a learning material within the repository model.
2. This will trigger orders/create events on our platform and will push the JSON payload to the Client API endpoint.
3. Client API will store on-chain asset data into Blockchain.
4. Order API will store order data in MongoDB.
5. Client API will send the email to the user containing the link to obtain ownership. The email is personalized and contains: user data, asset data and the private key.
6. User will receive an email containing the private key and be asked to obtain the Ownership generated by the platform.

Since webhook delivery is not always guaranteed, we should not rely solely on receiving data from webhooks. To ensure no data is lost, we should implement reconciliation jobs to periodically fetch data from our platform. However, reconciliation jobs are not within the scope of this project.

### 3.1. Platform Development

While discussing and evaluating different approaches, we had a couple of requirements that we wanted to have:

- **Separate loosely-coupled components** - that can be developed separately, replaced and scaled individually

- **Autonomous deployments** – we’re planning to do frequent releases, possibly for each feature or release hotfixes on a specific service or client without having to deploy the entire platform

- **Availability and Resilience** - we want to have fault isolation and ensure that the broken service can be replaced making the system resilient

- **Ability to change the Tech stack** – we didn’t want to have long term commitment to one technology stack.

Based on the above mentioned requirements, microservices architecture was the right approach for us to take. Each service would run in its own process and would have its own release pipeline. These services are built around business capabilities and are independently deployable by fully automated deployment machinery. They will be smaller in size and specialized which makes them easy to understand. They will be decoupled which means that we can refactor a service without having to fear breaking the other components of the system, or slowing down the development of the other teams.

However, the approach we took was a combination of microservices and serverless approach. A serverless application shares some of the same characteristics as a microservice, and even looks very similar to a microservice, but is very different in a number of ways.

Figure 4 shows how the model is deployed on AWS (Amazon Web Services).

The web client is deployed in a S3 bucket served through AWS CloudFront. The domain name is hosted on Route53 and mapped to CloudFront DNS. Besides AWS API Gateway and Lambda functions, everything else is deployed in Kubernetes (AWS EKS). We have three worker nodes each residing in a different availability group and an autoscaling group configured to automatically add more worker nodes if there is a huge workload on our site. This however is managed by Kubernetes Cluster Autoscaler.

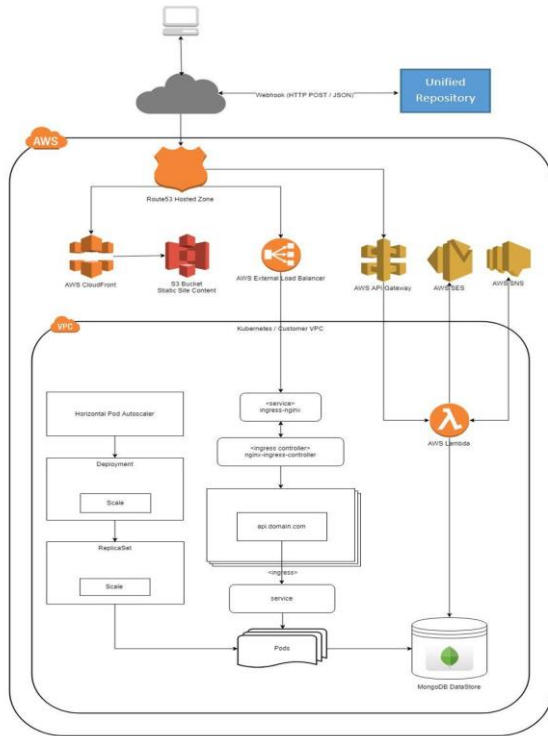


Figure 4. AWS: Model Deployment

Cluster Autoscaler automatically adjusts the number of nodes in a Kubernetes cluster when there are insufficient capacity errors to launch new pods, and also decreases the number of nodes when they are underutilized. Autoscaler adjusts the number of nodes by changing the desired capacity of an AWS Autoscaling Group.

By using Kubernetes and AWS together we have created a fully managed, continuous deployment pipeline for container-based applications.

The proposed unified repository architecture should have the following characteristics:

- **Open:** will create interoperated and connected applications, thus commercial tools from different universities could be assembled into a single system.
- **Scalable:** the architecture must be defined to grow in the future. For example: as the educational repository number increases, the applications in

charge of the management must have enough capacity.

- **Global:** To allow the linguistic and cultural diversity.
- **Integrated:** Not only among the components of the system but among other applications that are not directly related to learning (such as: human resources, knowledge management systems).
- **Flexible:** the ability to implement new solutions without making big changes in the system architecture is very important.

#### 4. Conclusions

The suggested model promoted in this paper aimed to give meaning to the technological needs of Balkan University Association according to the use of their online learning repositories effectively, especially integrating all their learning services within a repository and sharing to each other.

A unified repository is a web-based database application software that is used for simplifying the tasks of sharing learning contents, and resources between different universities through providing a unified solution and access point. Our aim is to propose a model for building a unified e-learning repository system for Balkan University Association (BUA), to enable academics to store, classify, access and share teaching and learning materials, BUA resources and not limited to.

Using it in educational institutions will promote huge benefits such as high available services, scalability, increasing portability ad reliability improvements.

#### Conflict of Interest

There is no conflict of interest.

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