Dynamic Customization of eTextBooks

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Abstract— **There is no reason eBooks should be monolithic containers of digital information, handled only with tools emulating their counterparts in paper. In this article, we propose to structure electronic text books (eTextBooks) as large numbers of low-granularity units that can be created, replaced and deleted independently by learning communities. We also propose a software service to dynamically deliver content units to eBook devices according to specified requirements. Our software service is deployed in public clouds infrastructure.**

eBook; ePublishing; learning as a service; cloud education accessibility

I. INTRODUCTION

The market for electronic books (eBooks) is rapidly growing and the publishing industry is constantly defining new concepts of eBooks. Consequently, eBooks content has evolved from text and images to richer multimedia assets. Nowadays, it is possible to customize eBooks in simple ways such as setting text size or adding annotations (bookmarks, highlights, notes, clippings) [1]. However, customization capabilities in eBooks are limited due to their treatment as monolithic entities. To overcome this constraint, we propose a new approach where eBooks can be handled as structures that can grow or shrink, and whose information units can be created, replaced, and deleted independently by users. Dealing with low-granularity units offers opportunities to collaborative publishing, which in turns allows customization guided by information needs. Thereby, each publisher community would produce content suited to their interest.

Our approach would benefit from using a cloud computing infrastructure due to the facilities that the Cloud offers both to service provides and users. In the Cloud, "service providers enjoy greatly simplified software installation and maintenance and centralized control over versioning; end users can access the service "anytime, anywhere", share data and collaborate more easily, and keep their data stored safely in the infrastructure." [2].

The proposed approach can be especially useful for educational and learning communities whose aim is to promote the construction of knowledge both individually and collectively. To this end, these communities must use mechanisms to guide and assess learners' progress. Our approach supports the teaching-learning process in two ways. First, by allowing collaborative publishing to physically distributed users. Secondly, by offering the possibility to customize eTextBooks as learning environments with learning assets (i.e., text, images, audio, video, 3D interactive objects) required by each student at any time.

The rest of this article is organized as follows: the background of the paper is presented at sections II and III. Whereas section II outlines the fundamentals of eBooks technology and its impact on education, section III deals with the use of cloud computing in learning environments supported by eTextBooks. Then, section IV presents a usage scenario of our proposal, and in section V, we describe the architecture of our eTextBook service (eTBS). Finally, we present the conclusions in section VI.

II. EBOOK CURRENT TECHNOLOGY: ITS IMPACT ON EDUCATION

Publishers are preparing for the digital future of books in general and textbooks in particular. They are indeed attracted by the possibility to produce, modify and distribute their products cheaper by focusing in target customers. A main challenge is to avoid the proliferation of publishing formats generated by platforms of eBooks distribution, namely Kindle for Amazon, Nook for Barnes & Noble, iBook for Apple, Kobo and Sony Google. In this sense, the International Digital Publishing Forum (IDPF) is doing a successful effort to define a publishing standard: ePUB that is being adopted by the main. Only Amazon has not embraced the format yet. Apple belongs to the IDPF Forum but its file-format is not fully compatible with ePUB.

ePUB3 is the third major release of the open standard format of the IDPF for digital publications and documents. The specification is based on web-standards shaped to specific books needs. Briefly, ePUB3 is XHTML content with some additional structure and metadata packaged in a .zip file (see Fig. 1). It emphasizes the dynamic typesetting of content adapted to the reader consumption taking into

account screen size, screen resolution, preferred font size. Besides, it enables structured and accessible content that is interoperable between devices both for downloaded and online consumption. ePUB, it provides video an audio support; text and audio can be synchronized and allows Java Script execution.

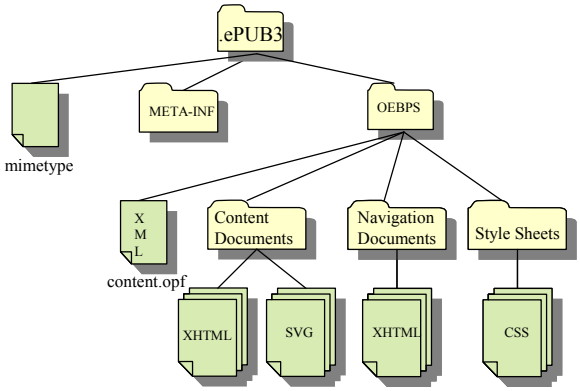

Figure 1. Structure of an eBook following ePUB3

From an educational perspective, traditional books are more suitable as tools for behavioral practices of education where students are passive consumers of information. Books act as close containers of organized information with limited possibilities of active learning. Among these possibilities is worth mention annotating, an effective and efficient study strategy which promotes learners' active involvement in constructing ideas [3].

eBooks ease lecture comprehension with the inclusion of dictionaries and the possibility of consulting other sources of information interactively via web. Comprehension is also facilitated by eBooks capabilities to provide multimodal information adapted to learners' perception preferences [4].

With the advent of eBooks, learners become active actors in the building of knowledge. Highlighting and annotation acquire a social dimension when combined with cloud computing and web services. For instance, these social features are already provided by Kindle and Kobo. These eReaders allow sharing eBook comments and highlights to Facebook and Twitter.

Learners' engagement is promoted by interactive capabilities of eBooks. Learners can manipulate virtual objects, simulation of experiments and on-reading testing receiving the feedback that stimulate active reflection. Apple has been the pioneers integrating interactivity into their iBooks textbooks.

Models of instructional design that promote deep learning establish that (1) learning is a product of understanding; (2) understanding occur best through performing tasks and (3) learning is a social activity [5]. These three factors can be fulfilled by eBooks with current technology. However, further efforts are necessary to turn the eBook into an integrated learning environment where students be guided in meaningful activities and the social construction of knowledge will be not only allowed but actively promoted.

The aim of this work is to contribute in the social aspect of building knowledge by a community of learners using eTextBooks as learning environments.

III. CONSIDERATIONS ABOUT THE USE OF CLOUD COMPUTING IN LEARNING ENVIRONMENTS SUPPORTED BY ETEXTBOOKS

Internet and mobile devices have democratized the access to data; they have contributed to impose the culture of ubiquitous access to information. Meanwhile, a silent revolution was taken place in the scientific world, technology known as grid computing enabled sharing, selecting and aggregating of a wide variety of geographic distributed hardware and software resources to communities of scientists [6]. Pioneers of grid computing where following L. Kleinrock's vision: "As of now, computers networks are still in their infancy, but as they grow up and become sophisticated, we will probably see the spread of *computer utilities* which, like present electric and telephonic utilities, will service individual homes and offices across the country" [7] an cited in [8].

According to the National Institute of Standards and Technology (NIST) [9], the cloud model is composed of five essential characteristics: on-demand self-service, broad network access, resource pooling, rapid elasticity and measured services; three service models: Platform as a Service (PaaS), Software as a Service (SaaS), and Infrastructure as a Service (Iaas) and, four deployment models: private, community, public and hybrid cloud. It includes market-based resource management strategies previously used in Grid computing to guarantee performance, availability, latency and quality-of-service (QoS) requirements. These requirements are constrained by the availability and capability of resources, performance measures and costs.

Cloud computing is a relative new phenomenon and large companies are still anxious about data failures, slow delivery of data over a network, and vulnerability of their confidential information. However, the most relevant eBooks sellers such as Amazon, Apple, Barnes & Noble, Kobo Inc. offer their eBooks services through the Cloud proclaiming the facilities to access the book any time, any where and, using any portable device. Using the cloud as a distribution platform has also reduced the books' prices. Finally, the cloud has also provided a medium to establish communities of readers as in Kobo Inc.

The educational sector is starting to embrace cloud computing. An initial overview of the use of cloud computing in education has been presented by N. Sultan at [10]. In the study, the Washington State University's School of Electrical Engineering and Computer Science and schools of Kentucky's Pike County district are mentioned as examples of institutions which use cloud platforms (cSphere4 and IBM data center respectively) to reduce costs. Amazon Web Services is been used to support peaks of workload of the course "Software Engineering for SaaS" of the University of California At Berkeley. Google Apps is been used at the University of Westminster and several African schools to rely on the latest technology and reduce

costs. Thus, education institutions seem to be opened to this new paradigm.

IV. USAGE SCENARIO

Omar, María and David are starting the module "People and Societies" in their History course. They live in different districts in Madrid and belong to three different schools which are using our eTextBook service to support the course. Omar, María, and David are Muslim, Catholic, and Jewish respectively.

As a pilot experience, Omar's teacher coordinates the "People and Societies" module and customizes the eTextBook for all the three classes involved. She decides to include the basic content provided by the publisher along with multimedia assets produced by last year students about popular music of the three cultures involved. This year, these three classes will be deeply involved in learning about religions. Thus, Omar, María, and David will lead in their respective classes the organization of relevant information. Each school will augment their eTextBooks with the consensual information generated by their students. Finally, Omar's teacher will be responsible for customizing the final eTextBook for all the community.

Students work in their assignment in class using the eReaders provided by the schools, and at home using their smart phones. All devices have access to our service through a public cloud infrastructure which guarantees content accessibility.

Finally, education authorities in Madrid decide to use eTBS for this History course in all schools in Madrid. The scalability of the pilot is guaranteed by the use of a commercial cloud computing platform.

V. ETBS ARCHITECTURE

The eTBS architecture proposed herein is a four-tier architecture with a Presentation layer where the client is a eBook reader based on Readium, the eBook Layer allows users to access the eTextBook service, the Core Layer with a set of general-purpose services and the Data Layer to handle learning assets and students' records. This architecture is depicted in Fig. 2 and offers a complete service to customize eBooks using a public cloud infrastructure.

A. Presentation Layer

Students will access their electronic text books though the Readium eReader which is based on ePUB3, the third major release of the standard ePUB for digital publications and documents. ePUB3 has features to embedded audio, video, scripting and interactivity within eBooks that might cause a significant impact on learning.

B. eBook Layer

Users interact with the services of the application through the eBook Layer. Users might include new learning assets by using the Resource Allocation Service and customize the eBooks with the Integration Service.

System administrators grant users' permissions through the Administration Service whereas the Resource Allocation Service allows users to include new learning assets in the Data Layer. The type of assets that a user can include in the Data Layer will depend on permissions granted.

The Integration Service enables the customization of eBooks. An eBook will include not only learning assets but also information related to students' profiles, team organization as well as the context and particular needs of the course. Students' profiles refer to students learning style, perception style and special difficulties. Team organization will determine who should share what assets. Context will be useful to choose contents relevant to a student community. The Integration Service is possible thanks to the scripting capabilities offered by ePUB3, with previous ePUB releases, this service is not feasible.

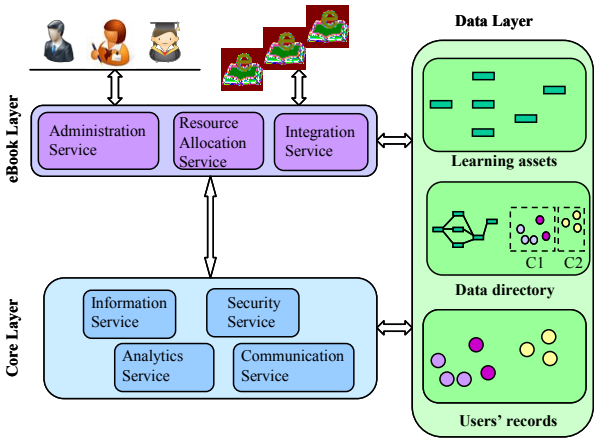

Figure 2. eTBS architecture

C. Core Layer

This layer provides essential cloud services for any eBook such as the Security, the Information, the Analytics, and the Communication services as well as a set of services required by the learning community.

Core Layer is also possible thanks to the scripting capabilities of ePUB3.

D. Data Layer

The Data Layer contains the learning assets that can be included in an eBook (Learning assets); data about the users of the application (Users' records) as well as the organization of the data (Data directory).

Learning assets encompass not only text and images as in any traditional book or eBook but also, multimedia elements such as video, audio, and 3D interactive objects that are beginning to appear in eBooks. Unlike current eBooks, learning assets are stored as low-granularity units along with metadata in the Learning assets area.

Data about users (students, teachers and editors) is stored in the User's records area along with metadata that allows for the structuring of the data as information for services. For instance, metadata includes users' security permissions and students' grading.

Data included in the Learning assets and Users' records areas are structured in the Data directory area in order to be recovered according to users' requirements in the context of

core or eLearning services. For instance, learning assets are organized as dependency trees and all the assets referring to a specific learning topic can be accessed and then selected according their tags; students can be organized by courses and (or) working teams.

E. eTBS Architecture in the Cloud

We are using the ePUB3 standard for structuring the information in eBooks and Readium as eReader. ePUB3 supports a wide range of publication requirements, including complex layouts, rich media and interactivity, and global typography features.

The application development is been carried out at Universidad Carlos III of Madrid using Ruby on Rails as agile application framework. In a first step, the eTBS architecture will be deployed as a web service in our laboratories. In a second development step, we will use two public clouds that provide infrastructure as a service (IaaS). The services included in the eBook and Core layers (Fig. 2) will use the Amazon Elastic Compute Cloud (EC2) to configure the compute and network infrastructure. The eTBS's storage infrastructure (data layer in Fig. 2) will be configured using Amazon Simple Storage Service (S3).

VI. CONCLUSIONS

Electronic books allow adapting learning to new millennial learning styles, promoting the exploration and building of knowledge in group. The customization of books by specific communities intends to engage participants in the learning process.

Our approach is based on low-granular information, collaborative publishing, and customization of information according to specific needs of a community of readers. Cloud computing allows reducing costs and scaling the learning environment to bigger communities easily.

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