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A WEB SERVICE APPROACH TO M-LEARNING WITH SHARABLE CONTENT OBJECT REFERENCE MODEL

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ABSTRACT

M-learning enhances collaborative learning and increases learning flexibility by allowing it to be more personalized and student-centered. But on the other hand, m-learning faces interoperability problems with LMS. This paper introduces personal mobile Web services, a new user-centric Web service architecture hosted on mobile devices, introducing the Moodbile project that provides an extension of Moodle Web services for mobile integration and mobile clients ready to use on real courses.

Keywords: *Learning Management Systems; Service Governance; Web Service; Learning Object Metadata; Sharable Content Object Reference Model*

1. INTRODUCTION

E-learning has experienced an extraordinary growth over the last years; learning paradigms, technological solutions, methods and pedagogical approaches have been developed, but some of them discarded. The demographics of college students also are changing, and the changes in knowledge and skills catalyze the need for ongoing professional development of the existing workforce. More and more higher education institutions use Electronic learning (E-Learning), as a tool to assist delivering educational resources including text, picture, multimedia or video what are made by computer software to students, either as a supplement to courses delivered traditionally or as an entire course offered online. E-Learning as a contender to classical face-to-face learning is broadly defined as learning through electronic devices. It is sought to further enrich this process with the ability to access all the educational resources wanted, when it is wanted, that is to say that knowledge can be available all time. This objective could be considered as the main target of learning platforms (LMS, Learning Management Systems) [1, 2]. One of the most extended platforms of learning is Moodle.

The successful convergence of resource-rich mobile devices, high-capacity wireless technologies and service oriented architecture has the potential to redefine the mobile computing experience. Nowadays, with the development of mobile devices (especially mobile phones booming) and trends mobile applications in the areas of modern life such as communication, entertainment and education, a new form of learning environment was any setting in which students can become totally immersed in the learning process, namely, the mobile learning (M-Learning).

The term M-Learning refers to the use of handheld devices such as personal digital assistants (PDAs), smart phones, Tablet PCs, e-Books, palmtops, and any other mobile microprocessor-based information technology devices that can be used in teaching and learning anytime/anywhere. Taking this into account, the next logical step in the development of E-Learning is to apply mobile

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technology to current LMS, the Mobile LMS. It can introduce a new range of mobile applications that promise advanced mobile computing paradigms and seamless data access. Mobile services, where the mobile devices act as the service providers, have not yet seen wide adoption. This primarily due to the constraints imposed by limited resources and power, and intermittent connectivity.

2. STATE OF THE ART AND RELATED WORK

The efficiency of online e-learning is improve by evaluating the student's performance, offering feedback to the tutor and providing reliable query response system with a combination of computational intelligence of online e-learning system and prosperities of intelligent mobile agent system. Authors proposed the personalization agent used in an online e-learning system to retrieve learning materials based on cognitive style, personal preferences and prior knowledge.

There are several studies of this type with Moodle but most of them are in process or are not released. One initiative is the Moodle for Mobiles project (MFM). MFM takes advantage of the current low fees for mobile email. MFM which uses the push email service (like RIM's Blackberry) to access the virtual class contents implements a gateway that sends updates from the Moodle web-based virtual classroom to iMode technology enabled devices. The use of the e-mail client (Blackberry, Mobile GMail, RealMail etc.) to get the information from the virtual class has an important limitation: it is usually used in Japan. Another initiative is the Mobile Learning Engine project (MLE). MLE provides a mobile client for Java Micro Edition (JavaME) that can be plugged to LMS software [3]. However this adaptation is always partial and specific of a particular M-Learning platform. In addition, it is developed under proprietary code and license, so the code is not available. Apart from these, there exist some applications for Moodle on the mobile but natives, that is, only for a specific mobile platform. For example for IPhone are mTouch, mPage, Moodle4IPhone or ILite. Also there exist specific implementations of Moodle for Android like MOMO, MBot or Moodbile. However, most of them are not operative or are not accessible.

To overcome such problem, the web requires an intelligent system, which can be implemented using SOA and Semantic web, in which computer can serve as an intelligent agent and then compute the meaningful information.

3. LEARNING RESOURCE REPURPOSING AND SHARABLE CONTENT OBJECT REFERENCE MODEL

3.1 Learning Resource Repurposing

Creating e-learning material involves several components: once content is developed, it must be managed, delivered and standardized. Content comprises all instructional material, which can range in complexity from discrete items to larger instructional modules. A digital learning object is defined as any grouping of digital materials structured in a meaningful way and tied to an educational objective. In order to improve the reuse of educational resources in digital format appears the concept of "learning object"(LO).

LOs represent discrete, self-contained units of instructional material assembled and reassembled around specific learning objectives, which are used to build larger educational materials such as lessons, modules, or complete courses to meet the requirements of a specified curriculum. A LO

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includes not only educational content, but also metadata descriptions that describe the own object and make easier its use and location in other contexts, then LOs standards are used. An example of the metadata's standard is the LOM (Learning Object Metadata) XML scheme [4], which was developed by LTSC.

LOM defines a wide range of metadata to classify and characterize learning resources, which include: overall description (cataloguing, annotations, and associations and relationships with other learning resources), technical data (file size, format, and installation/usage descriptions), and educational data (educational purpose, learning objectives, classification), and management data (intellectual property rights). The purpose of this standard is to facilitate search, evaluation, acquisition and use of LOs, both by students and instructors, or even automated software processes. However, there are no generally accepted conventions for properly describing learning objectives or the learning context, and although attempts have been made (such CLEO, and Educational Markup Languages) these only capture some of the semantics; thus more complex models are needed.

We use the term "learning resource" to imply a defined package of structured, factual information that is linked with a specific educational context. Here, context is defined as a set of circumstances in which an educational resource is used or may be used. The various ways of exploiting educational resource as social objects have been implemented in the MetaMorphosis$^+$ social network [5,6], which can be viewed as two distinctive and interacting networks. MetaMorphosis$^+$ is based on three-layer architecture:

(a) Educational Web data and service layer: it consists of Web services exposing available educational resource metadata that exist in disparate Web repositories.

(b) Educational data and service integration layer: it facilitates integration of actual LOM.

(c) Educational application and presentation layer: it will be discussed in part 4.

3.2 Sharable Content Object Reference Model

Sharable Content Object Reference Model architectural model is very popular among the web-based online e-learning systems. The additional service provided by this model among others is content management system. The system provider has a flexibility to make available the content of learning material according to user. It also has an API adapter which helps to provide application level interface that is independent of programming languages. It provides the information using web browser only.

4. M-LEARNING ARCHITECTURE WITH SERVICE GOVERNANCE AND SOA

The general system architecture of M-Learning based on SOA is divided into subsystem components for applying tier (layer) based and component based system design approach for its functionalities [7,8]. The system is mainly focused on SOA and its components include Database Layer and Service layer.

4.1 Database layer

Database layer consists of LOs, including context data, content data, learner's profile and test. First, the context data is the information about location, time, and manner that learners take part in the course via a mobile device. Secondly, the content data stores information about course materials that

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reflects in the content model. The learner profile represents personalized information of each learner including learner's interests, learner's knowledge level, and interval of time that learners requested. Finally, test data consists of several questions for testing student's knowledge level. Besides, test data also store the results of learner's test.

4.2 Service layer

Service layer is the layer that holds services composing core of the M-Learning. It is the main gate of the system with users and other services providers/consumers. M-Learning has two main types of services: service publication, and service discovery. Service layer has three sub layers: Agents layer, Business layer, and Web Service.

4.3 Agents layer

Specific task agents are required to serve system. Software agents are always the optimum solution for track and analysis tasks. Software agents are: Analyzer, and Tracker Agents. Analyzer agent is the software agent that analyzes system's log to detect most happen reasons causing failed imports, thus provide a feed-forward dynamic M-Learning [9]. Tracker agent is the software agent that is responsible for ensuring that instructors provided feedback for courses they have imported.

4.4 Business layer

Business layer manages interaction details required to ensure that service operations are executed in a specific sequence. This layer provides Service Governance to the SOA framework of our system. It sets rules on the access of all services.

4.5 Web Service

SOA which includes Assessment Service, Grading Service, Marking Service, Course Service, LOM Service, Tracking Service, User Service, Sequencing Service, Reporting Service, Delivery Service, Learner Profile Service and Course/Content Service.

4.6 Service Governance and SOA

M-Learning systems can be developed anywhere and depending upon their locations, the system configurations can vary. It is not feasible to accommodate all necessary changes without Service Governance and SOA.

```
Algorithm 1: User Service publication.
Input: service XML summary document f_si
Output: null
Function Publish(f_si)
   Parse f_si
   Set the provider P
   Set the publication depth d

   L = L_local
   foreach LOs lo_i in L do

      if s exists in sdir then
         update s
      end
      else
         add s
      end

      if d > 0 then
         d = d - 1
         update d in f_si
         Call Publish(f_si )
      end
      else
         return null
      end
   end
```

Algorithm 1 outlines the proposed publication mechanism for user services. The publication process is distributed and recursive in those providers can allow LOs to propagate the publication of the service on their behalf using their own resources. The publication depth d indicates how far the service provider wants the advertisements to reach. The LO list L is initially set to the providers' LO list Lp. A LO lo_i receives the service advertisement, reduces d by 1 and republishes the service to its LO list LO_i , according to a prespecied pattern of access rights for indirect LOs. These access rights are set by

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providers via appropriate mechanisms. The publication stops when d reaches "0". If the service provider sets d to "0" for a particular service s, it means that s is only offered to the provider's direct LOs and the recipient of the announcement is not allowed to republish it.

The discovery mechanism applies Algorithm 2 to find Web services relevant to a user's request by matching the required functionalities with capabilities offered by Web services. The algorithm is also distributed and recursive like the publication algorithm. It ranks the retrieved relevant services (RelS) according to the similarity between the required functionalities by a user request and the offered capabilities by a Web service.

```
Algorithm 2: User Service discovery.
Input: Web service request SR, discovery depth d
Output: set of relevant Web services RelS
Function Search(SR,d)
  extract functionalities RF from SR

  foreach s in sdir do
    extract capabilities SC from desriptions
    rank=match(RF,SC)
    add s to RelS indexed by rank
  end
  if RelS is null then

    if d > 0 then
      d = d - 1


      L = Llocal
      foreach contact ci in L do

      Call Search(SR; d)
      end
    end
  end
  return RelS
```

M-Learning systems can be developed anywhere and depending upon their locations, the system configurations can vary. It is not feasible to accommodate all necessary changes without Service Governance and SOA. Mule ESB is a lightweight Java-based messaging framework that allows you to easily connect your applications, extend the functionality of the bus and enable them to exchange data. Mule is based on ideas from Enterprise Service Bus (ESB) architectures. The strict separation of configuration and business in Mule was another reason to choose Mule for M-Learning.

Endpoints are configuration elements that are the key to wiring together all the services. By specifying endpoints in the inbound and outbound routers to tell Mule which transport to use, where to send messages, and which messages a service component should receive. The primary part of an endpoint is the address, expressed as a uniform resource indicator (URI), which indicates the transport to use, the location (a transport-specific resource), and any additional parameters. Mule Galaxy, a governance solution for Mule, is a SOA governance platform, often referred to as an SOA registry/repository. Galaxy aids in the management of SOA by providing features such as lifecycle, dependency and artifact management, service discovery and reporting, and application deployment management. Galaxy can provide a global configuration application.

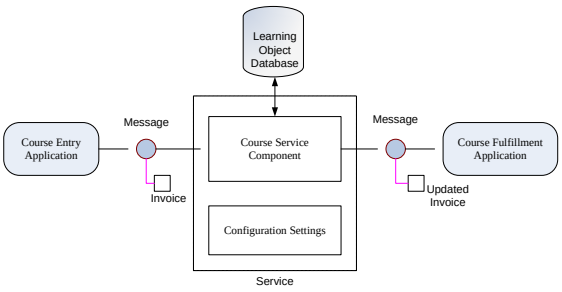

Fig.1. Processing the LO in M-Learning

When a message is sent from an application (such as the invoice from a course entry system), Mule picks up the message, sends it to a service that processes it using some specific business logic (such as checking the LO databases), and then routes it to the correct application (such as the course fulfillment system). Mule contains many

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individual parts that handle the processing and routing of the message. The key part of the service is the service component. The service component executes business logic on messages, such as reading the invoice object, adding information to it from the customer database, and then forwarding it to the course fulfillment application (shown in Fig.1).

Mule Galaxy can get control over M-Learning infrastructure by providing the following features:

a) Governance: provides a centralized control point for M-Learning's policy management and compliance, ensuring that SOA adheres to M-Learning's policies.

b) Registry: automatically detects and displays dependencies among services and manages service lifecycles.

c) Repository: stores and manages artifacts (including LO & LOM, Mule configuration files, web services frameworks, and any other artifact), providing version management and collaborative comments, and publishes the course materials in mobile.

5. CONCLUSION AND FUTURE WORK

In this paper, we propose an approach to apply mobile technology to portal-based E-Learning system and design an M-Learning system based on the principles of Service Governance in SOA framework. The approach to design an M-Learning makes it S.C.A.L.E. Applying Service Governance on SOA for rendering and designing different system services makes the system more usable from business aspects. Service Governance provides rules and policies on the use of services. It also provides security and privacy to M-Learning. The experience and performance results gained from the system design and implementation processes provides us with positive feedback regarding a successful and efficient system design approach for a ubiquitous system. We believe this is a trend in future development of M-Learning Systems and the system approach can be applied to the systems in other fields with similar stringent requirements.

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