

## General Architecture to an Adaptive Hypermedia System

S. Sanz Lumbier, J. A. Vadillo Zorita, y T. A. Pérez Fernández

Dept. of Computer Languages and Systems, University of the Basque Country (UPV-EHU), Paseo Manuel de Lardizábal 1, 20018 San Sebastián, Spain

In this paper, the architecture of a Generic Adaptive Hypermedia System, NATASHA, is presented. This architecture has been developed to solve the deficiencies of the current AHS. It is based in the last e-learning trends. Thanks to this, the system will be able to edit educative materials, items and tests which are reusable and it allows different types of evaluation. But, it isn't only to NATASHA, this architecture can be apply to any AHS. Besides, the different modules and the interactions among them are explained.

**Keywords:** architecture, standards, Adaptive Hypermedia System

### 1. Introduction

E-Learning is any system that uses the electronic technology to deliver educative materials. The Adaptive Hypermedia System (AHS) is within this group. The main difference with the rest of the e-learning system is that they provide an adaptive navigation to the user.

Nowadays, there are numerous AHS. However, these systems have some deficiencies which are explained below.

One of the biggest problems is that a lot of these systems are proprietary. This entails all the costs and efforts that are put into creating courses, items and evaluation tests are wasted because they can't be reused for other systems.

The majority of the AHS are systems to teach a concrete subject. In the market, there are some generic systems to manage educative materials, but they aren't adaptive, WebCT, Moodle, etc.

Other problem of the AHS is in the evaluation of the student. The most of these system use predefined tests. Besides, these tests only assess the knowledge of a concept of a simple pedagogic domain and they don't assess the knowledge of the relations among the concepts mentioned above.

The objective of this project is the development of NATASHA, a Generic Adaptive Hypermedia Educative System, which solve the deficiencies named above. In first place, NATASHA has to make possible the edition of contents, items and tests, which are reusable and interoperable among different systems.

Second, the system must permit the evaluation using as much classic test (predefined and dynamic) as adaptive tests based on TRI [4]. Besides, this evaluation will be made about all types of concepts and relations.

Finally, the system allows an adaptive navigation, that is, the system will decide, what is the next learning object to present to the student according to the evaluation done about the different concepts and relations.

In this paper, one presents the architecture of NATASHA. For this, a review of the architecture of e-learning system is made and next, a new proposal is introduced. Although, the development of this architecture was motivated for the construction of NATASHA, its main objective is that it was applied to any AHS. Finally, some conclusions are given and the future lines are presented.

### 2. Review of architectures of e-learning systems

The typical architecture of the AHS consists of: a domain model, a user model, the interface and the didactic module. The pedagogic domain and the didactic resources are stored in the domain model. The

knowledge of the student the preferences, the learning objectives and the general characteristic (name, password, etc.) are saved in the user model. The interface is the component destinate to the user interacts with the system. It is responsible for gathering the request of the user and for showing him the learning resources. The didactic module acts before the events which are sent by the interface and collaborates with the pedagogic domain and the user model to personalize the answer to the characteristics of the student [10].

Some new modules have been included in some systems. These modules have been necessary because the functionality of the system has increased. An example is AHA![2], where a new module with two author tool has been added. The first one is to make the adaptation rules and the second is to define the relations.

Nowadays and thanks to standardization process of the learning technology, a new proposal of functional model has been introduced. This new model allows the communication among different learning systems. In this way, the systems will be able to exchange from learning resources to information about students [13].

The system is divided into Learning Management System (LMS) and Learning Content Management System (LCMS). The LMS, as its name suggests, manages the learning. It is in charge of storing the information about the student, obtaining the user's request and locating the courses. The LCMS is in charge of the management of the contents to personalize the resources to every person. It is the environment where the developers of contents can edit, store, reuse, manage and deliver contents from a repository centre.

The IEEE also has a group, called LTSA, working on topics of architecture, but the results is more a conceptual model than a reference architecture [8].

### 3. Architecture of NATASHA System

The architecture has been developed beginning with the typical structure of the AHS and the last e-learning trends. It is divided into two parts: LCMS and LMS [Fig. 1]. In this way, the process of standardization and reusability of the educative resources and students profiles is easier. Next, the components that compose the division, their functionality and the interaction among them are going to be explained.

#### 3.1 LCMS

One of the components of the LCMS is the *author tool to contents generation*. This allows the teachers and the experts to create the learning objects that constitute the domain model. NATASHA divides the domain model into two parts: the hyperspace and the knowledge space. The hyperspace consists of all educative resources created to teach the pedagogic domain: activities, presentations, videos, etc.

The union between the knowledge space and the hyperspace is done through the metadata. The metadata describe a resource or an object. Nowadays, there are different entities working in its standardization: DCMI, LTSC, IMS and ADL. DCMI has a scheme of metadata called "Dublin Core" (DC) [3] that uses a set of 15 attributes for the description of the elements. "Learning Objects Metadata Standard" (LOM) [6] by LTSC is an extension of DC. Every learning object can be described using more than 70 attributes divided into 9 categories: general, lifecycle, meta-metadata, technical, educational, rights, relation, annotation y classification. The work of IMS [5] isn't only related with the metadata. It also offers a set of specifications about profiles of learners, packed of contents, definitions of tests and questionnaires, etc. The result of work made by ADL is SCORM [11]. This model is the result of selecting and improving the works developed by other organisations. For instance, it uses the LOM model to describe the contents and the way to pack them is a better version of IMS.

All the learning objects that are the resources together with their metadata are stored in the *contents repository*.

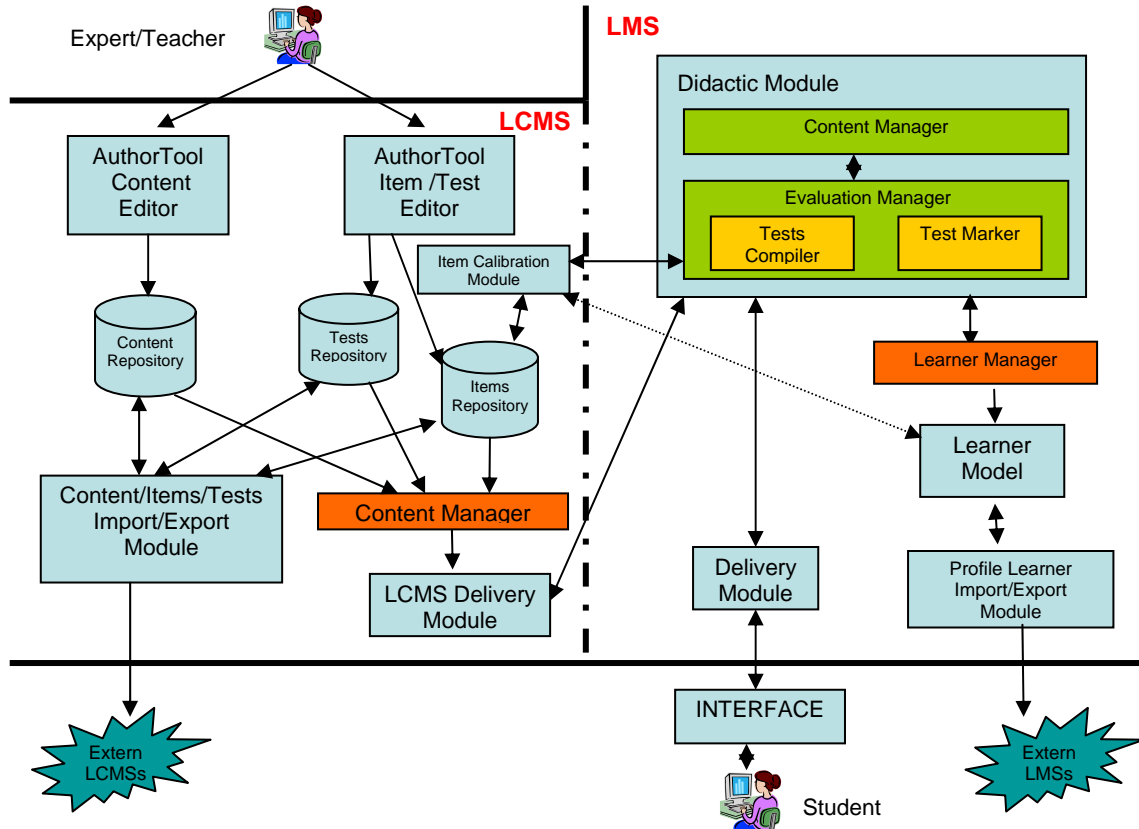


Figure 1. The architecture of NATASHA system

Another component is the *tool of items and tests generation*. It allows the teacher or the expert the creation of different types of items and starting from these, the generation tests. The types of items can be: sort, multiple choices, union... In [1] there is a collection of types of items.

NATASHA offers the possibility of evaluating to the student using with 3 different types of tests: predefined, dynamic and adaptive. In the predefined tests, the items are prior to starting the evaluation process and it is the same for all the students. In the dynamic test the items are selected randomly form the *repository items*. Finally, in the adaptive tests, the items are selected form the replies given from the items before. For this, calibrated items according to the TRI are used [4].

The calibration consists in allocating to each item a difficulty grade which is going to adapt dynamically depending on the reply given by the users of e-learning system. The module which has to carry out this task is the *item calibration module*.

The items make possible the evaluation of the domain. For this reason, a relation between the item and knowledge space should exist. Each item should have associated the concept or the relation that is going to evaluate. The union between the items and the knowledge space is also carried out through the metadata. IMS has a standard, QTI, for the items representation.

The component in charge of the communication with the LMS is the *delivering module*. This is the responsible of processing all the request from the didactic module and carry out all the new request to the *contents manager*, which is in charge of finding the contents, tests or items.

The last module of LCMS is the one of *importation/exportation contents, tests and items*. The system offers the possibility of import/export educative materials, tests and items from other LCMS or from any repository. To do that, all the resources should be packed together as metadata.

### 3.2 LMS

One of the components of the LMS is the didactic module. It consists of the *content manager* and the *evaluation manager*.

The content manager is the one that decides which is the next learning material that the student should visualise and it makes the request of the resource to the delivering module of the LCMS. In NATASHA, this decision is taken according to the student knowledge level, his learning objectives and his preferences. All this data are stored in the student model and the interaction between these two components is carry out by the student manager.

The evaluation manager, as its named suggests, is in charge of the evaluation of the student. It consists of the *Test Compiler* that decides, which is the next item to be shown in the case of an adaptive evaluation, and *Test Marker*, which reviews the tests.

*Deliver Module* is another one that is responsible of the communication between the interface and the didactic module. Its works consists of delivering the didactic materials, tests and items to the interface and gathering the request of the interface and transmitting them to the didactic module.

The last component is the *importation/exportation student profiles module*. This offers the possibility of importing data student from other LMS and receiving request of other LMS's.

## 4. Conclusions

In this paper, a new proposal of architecture has been introduced. This architecture has three main advantages. In first place, the system allows the reusability and interoperability of any resource. Second, the architecture can be applied to develop any system and finally, the architecture permits an adaptive evaluation to the user.

Due to these advantages, NATASHA is very useful as much for the teachers as for students. The teacher can access to contents, items or tests previously developed and include them in their e-learning system and the students can be evaluated more precisely and faster thanks to adaptive evaluation.

Nowadays, NATASHA is in process of development. Some components are already realized, for example, the tool for item generation and the development of other modules is very advance. This is the case of calibration module or tests compiler.

The future lines are centred in the union between the adaptive navigation to the user and the standards. For this, the different methods of adaptive navigation and the different possibility of integration between them and the e-learning standards will be studied.

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