ECMS: TOWARDS A FEDERATED DIGITAL LIBRARY OF EUROPEAN EDUCATIONAL CONTENT

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Abstract

Asynchronous eLearning overcomes geographical and temporal constraints transforming learning into a process that can occur at the independently determined convenience of instructor and learner. Demand for asynchronous eLearning has been developing both by corporations seeking to extend the skills of their employees to remain competitive in a constantly evolving market and by professionals pursuing life long learning for the achievement of their career goals. Furthermore, asynchronous eLearning is used as a complementary educational tool for the dissemination of on-line material in traditional classroom education, particularly at the University level. Recognizing the fact that successful distributed teaching relies on the effective management of the wealth of available educational material, the eCMS project focuses on web-based federated content management infrastructures for the support of distributed teaching. The core of the system is an open, distributed middleware architecture for the publication, discovery, retrieval, and integration of educational material. The infrastructure is complemented with services targeting the specific needs of user groups involved in the eLearning process, i.e. learners, content providers, course managers, and repository administrators. eCMS supports standalone as well as distributed configurations with an emphasis on distributed digital libraries of structured, organized, or standalone educational content, possibly originating from independent institutions, allowing installations to evolve into educational content portals while at the same time maintaining the autonomy of organizations participating in an extend eCMS network.

1. Introduction

Asynchronous eLearning overcomes geographical and temporal constraints transforming learning into a process that can occur at the independently determined convenience of instructor and learner [1]. Demand for asynchronous eLearning has been developing both by corporations seeking to extend the skills of their employees to remain competitive in a constantly evolving market and by professionals pursuing life long learning for the achievement of their career goals [5]. Furthermore, asynchronous eLearning is used as a complementary educational tool for the dissemination of on-line material in traditional classroom education, particularly at the University level.

A wealth of educational material is available throughout Europe. However, a large number of academic institutions do not currently offer organized distance education programs. This lack of organized repositories for educational content stems from a need for tools enabling flexible development and management of structured courses, straightforward content publication mechanisms, learner-friendly information discovery and retrieval, and adequate self-assessment support. This need has led in turn to recent initiatives for the development and management of structured courses aimed for use through the Internet.

The eCMS project [2], partly funded by the European Commission's Minerva-Socrates program, aims at the design and development of a web-based federated content management system for the support of the asynchronous eLearning process. The core of the system is an open, distributed middleware architecture for the publication, discovery, retrieval, and integration of educational material. The infrastructure is complemented with services that target the specific needs of all user groups involved in the eLearning process, i.e. learners, content providers, course managers, and repository administrators. The eCMS system may be installed and managed as a standalone node or may serve as a node in a larger eCMS network of educational content, enabling eCMS installation to evolve into educational content portals.

The system moves a step further than existing content management systems in the following ways: eCMS recognizes that the structure of courses often reflects the academic practices and internal organization of academic institutions. Thus, the structuring of courses may differ from one organization to another. Furthermore, educational content providers are often professors teaching in traditional classroom settings,

who have already developed material, fixed pedagogical practices, and limited time to restructure content. Success of an on-line educational content publication service relies on its flexibility on course structuring. Rather than enforcing a predefined and arbitrary course structure, eCMS allows content developers to organize courses in a manner that best fits their academic practices through the support of flexible tree-like course hierarchies with no additional limitations.

Another key requirement for the success of eLearning content management services is ensuring the autonomy of participating organizations. While organizations recognize the benefits of publishing content through on-line management services, they are reluctant to offer content to a system that they do not fully control. eCMS takes advantage of digital library technology to build an open distributed repository of educational content. Furthermore, the federated nature of the middleware allows institutions to install and locally manage an eCMS node that may optionally be connected to a larger eCMS network. Finally, eCMS supports the plug-in of existing organized educational repositories through metadata importing and mapping agents, an important feature not offered by standalone eLearning management systems.

2. The eCMS Distributed Middleware Infrastructure for Educational Content

Figure 1 displays the eCMS educational content management node. Information is logically organized into separate data stores for metadata, content, and system statistics.

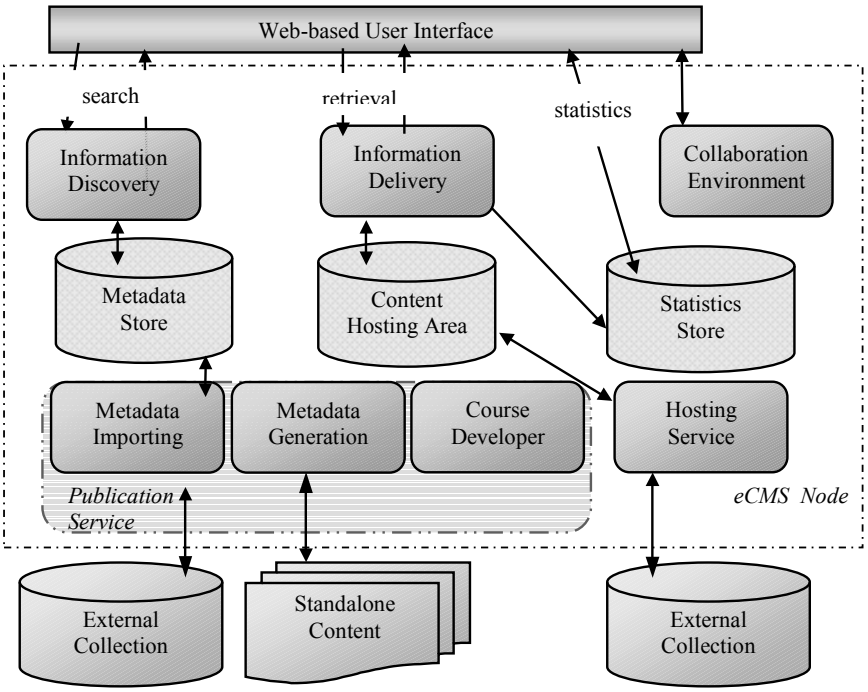

Figure 1. eCMS System Architecture

The *Metadata Store* holds a description record for each published educational module. The system supports optional hosting of material into a designated *Content Hosting Area*. Material is uploaded into the system through the *Hosting* Service. It is expected that this mechanism will typically be employed for the publication of standalone educational units originating from institutions that do not currently offer organized distance education programs or the infrastructure and know-how to manage content independently. Finally the *Statistics Store* holds transparently gathered statistics on system use. Analyzed statistics are available for review by both system administrators and course managers, who may use the information to evaluate their practices and identify points of improvement. Users interact with the eCMS

Content Management Node through a web-based interface providing customized library views targeting the needs of learners, content providers, course managers, and repository administrators.

Content providers can publish educational material in one of the following ways: (i) through the *eCMS Metadata Submission and Editing Wizard*, a facility that guides publishers through the step-by-step generation of metadata descriptions for educational entities. (ii) Through the *eCMS Course Developer and Editor*, which supports the publication of structured courses. (iii) Through the *Metadata Importing Wizard* for the transparent integration of entire external information collections.

Learners have access to published content through search and navigation interfaces that support text-based queries against the educational metadata. The system is extensible to support text-based queries against content. Content may be retrieved through the *Information Delivery Service* and presented to the learner in an appropriate format depending on the storage method and the intended use of the module (image, text, video, etc).

The Statistics Gathering and Analysis service automatically collects statistics on the use of offered services during the regular eCMS operation aiming at the constant improvement of the system functionality and content. Statistics include information on keywords used in queries, metadata records matched through queries, reviewed metadata records, and user information.

Finally, a collaboration environment developed through off-the-shelf tools facilitates communication between learners (e.g. group work) as well as learner-instructor interaction (e.g. office hours) thus aiding the learning process. The tools consist of chat-rooms, forums, and application sharing modules.

Additional Content Management Nodes are supported to ensure scalability as the amount of managed information increases. Each eCMS node manages a distinct metadata collection and corresponding content, as described in more detail in section "Support for Metadata Distribution and Distributed Queries".

3. Course Structure

One of the key hindrances for publishing content, particularly already existing modules, into eLearning libraries is the fact that many systems support a very specific course-structuring model. At first glance this may seem as a feature that simplifies the publication process and guides publishers through content development. However, this choice may prove a significant disadvantage when academic institutions wish to create distance education programs based on existing content and educational practices. The success of any open federated library for educational content relies on flexibility in the structuring of courses. eCMS achieves this flexibility by imposing the least possible structuring constraints. A hierarchical approach has been adopted. The providers may decide the types of educational modules they will use for course structuring purposes. Examples of currently supported module types include course, module, section, and subsection. The supported educational module types are dynamically managed by eCMS administrators, as opposed to being hard-coded into the system, and may be easily extended through straightforward on-line services.

Figure 3 displays an example of the representation of structured courses in the eCMS system. In the presented example a number of independent modules are displayed, interconnected with "contains" relationships. Thus, modules published through the system may be reused, provided that the publishing organization permits.

4. Summary of eCMS Services for the Support of Distributed Teaching

The following sections provide a high-level overview of the eCMS services implemented on the educational content management infrastructure described in earlier sections. Services are customized for each targeted user group, namely learners, content providers, course managers, and repository administrators.

Services for learners:

- Information discovery and retrieval:

- Search and retrieval: free-text search, search with options, search by eCMS record ID
- Repository navigation: by publisher, thematic area, and author

- Collaboration environment including chat-rooms, forums, and application sharing
- Participation to self-assessment examinations
- Feedback processes on the learning processes, educational content, and eCMS services through the submission of numerical rating for educational modules, text-based reviews of educational modules, email-based feedback on eCMS services, and an on-line questionnaire for
- Management of personal identification in the eCMS system through the creation of personal accounts and the maintenance of personal information
- Services manual

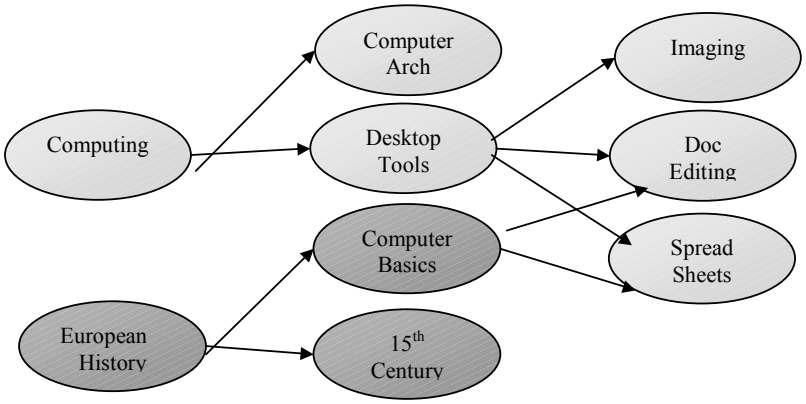

Figure 3. eCMS Course Structure Supporting Flexibility and Module Reuse

Additional services for educational content providers:

- Private work spaces
- On-line metadata generation and publication
- Management of educational content metadata (editing, deleting)
- Optional content hosting
- Access to learner content reviews and ratings

Additional services for course managers:

- On-line structured course developer and editor
- On-line multiple-choice examination developer and editor

Additional services for repository administrators:

- Account and group management
- Supported educational module type management
- Institution and publisher management
- On-line text-based metadata indexer start-up
- Importing of organized external repositories
- Support for the distribution of metadata and content

5. Support for Metadata Distribution and Distributed Queries

eCMS supports the installation of more than one eCMS nodes interconnected into a federated digital library of educational content. Thus, institutions may install an eCMS node in their premises and manage it through the provided Repository Administrator services. Remote eCMS nodes may be easily connected into a wider eCMS network through the support for *Metadata Distribution* and *Distributed Queries*. This feature ensures that publishers may get the best of both worlds: autonomy in the management of the content, scalability with respect to metadata volume, and participation in educational networks. eCMS hides the complexity of the federated content management infrastructure from users, who may submit a query through an eCMS entry point and receive merged results of query hits from all eCMS nodes.

The eCMS system implements distributed queries through metadata caching to alleviate the need for remote queries, thus resulting in faster query responses. This approach involves "synchronization" of eCMS metadata repositories. Specifically, it involves replication of remote eCMS metadata, which results in equivalent eCMS nodes, i.e. into eCMS nodes that hold the same metadata information. The Repository Synchronization service is available on-line to repository administrators, who may invoke it through a simple click of a button or program it for periodic execution, e.g. nightly.

6. External Repository Integration

External organized educational content repositories, which have their own educational metadata definition sets, may be integrated into eCMS through the Metadata Importing Wizard. The wizard works transparently to the external repository's normal operation and operates in the background as a demon that may be configured to poll the external repository periodically, e.g. nightly or weekly. The wizard imports external metadata records, maps the metadata to the eCMS metadata definition set through a mapping scheme that is specific to the external repository, and stores the mapped metadata into the Metadata Store as eCMS records that are subsequently indexed through the eCMS metadata free-text indexer.

9. Conclusions

This paper presented the eCMS educational content management system for the support of asynchronous eLearning through the creation of distributed networks of educational content, possibly originating from independent institutions, while at the same time maintaining the autonomy of participating organizations. The system provides an open scalable platform for the publication, management, and dissemination of possibly distributed, heterogeneous educational material. In addition to providing a platform for the publication and management of educational content, the system provides services for all user groups participating in the asynchronous eLearning process, namely learners, content providers, course managers, and repository administrators.

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