

Design and Development of a Web-based Course Authoring and Management System for Interactive, Multi-lingual and Personalized Multimedia Online Notes in Distance Education

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Abstract: This paper describes the design and implementation of a web-based web-based Course Authoring and Management System (CAMS) for organizing, integrating and composing personalized and interactive course notes for online education. A 5-layered architecture is proposed for the CMCAMS and is implemented using the Java 2 Enterprise Edition (J2EE). A Web-based distance education system has been developed over this framework to test its effectiveness. This system enables educators to manage personalized learning materials that are structured, profiled and streamed to students. It will examine the user's profile to identify what level of difficulty to incorporate and what kind of presentation style to adopt based on the bandwidth available to students. The CMCAMS uses XML and XSLT techniques to generate SMIL documents, which form the backbone for educational online materials. The CMCAMS has several essential features: (1) Remote Access (2) Easy to use (3) Support for Multi-Style and (4) Multilingual online multimedia content through SMIL presentation.

Key Words: Distance Education, Personalized Multimedia Online Notes, J2EE, XML, XSLT, SMIL

Introduction

Distance education is an important field in which the computers, web technology, multimedia technology and internet applications are integrated together to transform the traditional time and distance dependent model into a distributed learning model where time and location do not matter. In recent years, there has been an unprecedented expansion of distance education programs offered by universities across the world due to the advances in Information and Communication Technology (ICT). The exponentially growth of distance education programs has resulted in a great demand for a device-independent system that can serve the needs of designers, academicians and administrators so as to simplify the creation, delivery and maintenance of web-based distance education programs. Examples of commercially available systems, these include WebCT, Blackboard, E-College and Course Authoring and Management System for Interactive and Personalized Multimedia Online Notes ([http:// www. webct. com/ products](http://www.webct.com/products), [http:// www. blackboard. com/](http://www.blackboard.com), [http:// www. ecollege. com/ solutions/ Campus. html](http://www.ecollege.com/solutions/Campus.html), Cheong *et al.*, 2002) with WebCT being the most advanced and most diverse base of course management system for users in the world. However, a review of the advertising and marketing literature shows that these systems fall short of the use of multimedia technology for distance education. We believe that the use of multimedia technology in distance education will reduce the time devoted to learning. This is due to the following advanced features offered by the multimedia technology:

- **Student Interaction:** The use of multimedia in education increases the students' interactivity with the on-line notes thus enhancing and reinforcing the learning process.
- **Multiple Communication Channels:** Each of the multimedia components: text, audio, video, graphics and animation has its own unique characteristics that make it suitable for certain aspect of education. Thus, when all these elements are combined and used simultaneously in education, we believe that study materials can be

presented and conveyed more effectively to the students.

- **Personal Learning Process:** The use of multimedia technology in an educational environment promotes the personal learning process in which students can learn at their own pace without any distraction. Hence, students will be able to explore the content in a quick and simple manner, without hesitation. Nevertheless, the use of multimedia technology in distance education poses some challenges to content authors as detailed in the following:
- **Bandwidth:** Streaming multimedia elements in an online learning environment across the Internet poses a great challenge to academicians. Although availability of compressed video technology and higher capacity internet connections has increased greatly over the years, many rural areas in Asian countries such as Malaysia are still experiencing the slow internet connections. There exists a big gap between the bandwidth in a city and that in a rural area. Thus, students living in cities with fast Internet connection and a powerful multimedia PC will find multimedia technology an effective instructional medium for delivering information. On the other hand, students living in rural areas with slow Internet connection will experience a lot of problems in accessing the multimedia packed online educational materials.
- **Attention Span:** Student's attention span is another main issue. For instance, a student who had a course on Object Oriented Programming might want to skip the introductory concepts and jump straight into APIs, while a beginner would be better off going through the basics. The current trend of "one-size-fits-all" approach for multimedia education online materials is inadequate. With the flexibility allowed in the digital media presentation, an online learning system should try to accommodate the needs of as many students as possible through personalization.

- **High Production Cost:** The cost of multimedia material production and development process is very expensive and time consuming. Usually, there is a special team that work closely with academicians to compose the multimedia notes as most of the team members are not equipped with the knowledge of multimedia technology. For online notes involving a combination of multimedia elements such as video, audio, text and images, production will require a tedious multimedia composing. The academic personnel and multimedia composing team find it frustrating to collaborate for the production of multimedia online notes.

In this paper, we present a web-based Course Authoring and Management System (CAMS) that makes use of multimedia technology to produce interactive and personalized online notes while providing a novel approach for organizing, integrating and composing multimedia personalized course notes for distance education.

Materials and Methods

Design for Course Authoring and Management System:

Before proceeding any further, we will describe the process dealing with a life cycle of online notes and issues that should be considered in designing Course Authoring and Management System for distance education.

Life Cycle of Online Notes: This process organizes content from inception through deployment, eventually leading to archiving and deletion of educational online materials (Fig. 1). A successful management of the "life cycle of online notes" requires input from various individuals or teams from academic personnel and managers. However, with the advent of global corporations, there is a high possibility that team members may be situated anywhere in the world. During the authoring process, the online notes is composed of text, images, animation, video, sound or data in different proportions from the external source generated dynamically together with a pre-defined layout template. The online notes will be associated with a specific date of publication, removal and often a date of temporary archive before it is destroyed. The "life cycle of online notes" suggests that there should be a number of roles to be considered (Fig. 2):

- **System Administrators:** Responsible for the setup and ensures the smooth operation of CAMS.
- **Content Authors:** Provide an interface with CAMS to create or edit online notes.
- **Content Editors:** Provide an interface with CAMS to review, revise and approve submitted content to ensure high quality of content and consistency of styles.
- **Course Coordinators:** Provide an interface with CAMS to create items, make assignments and distribute tasks among academic staffs and approve submitted materials.
- **Template Developers:** Responsible for providing consistent styles for online notes and personalized multimedia presentation templates.
- **Content Publisher:** Provide an interface with CAMS to schedule deployment of online material on the site and ensure that it is current, appropriate and correct.

- **Student:** Access to CAMS with read online notes.
- **Design Issues:** The main objective of creating Course Authoring and Management System (CAMS) is to minimize the process of content authoring burden on the staff during the "life cycle of online notes", allowing more time on enhancing the learning experience of students with multimedia technology. As for the administrators staff, CAMS aims at creating a cost effective, robust, integrated, scalable and sustainable platform that will meet the needs of distance education. In our methodology, we address three issues that we consider central for producing a flexible and easy to use course authoring and management system:

- **Remote Access:** The system must provide a collaborative and integrated environment to academicians, administrators and students despite the challenges of time, location and machine.
- **Easy to Use:** The system must allow a relatively simple and straight forward method to manage and compose personalized online notes from the digital archive of educational materials to cater the student attention span.
- **Multiple Bandwidth Support:** The system should allow students to access to multimedia online notes regardless of the internet connection speed.
- **Multimedia Support:** The system should devise an easy way to compose and synchronize multimedia elements to reduce the production cost in creating online notes.

A Framework for CAMS: The framework for CAMS presented in this paper is built on top of the J2EE platform (<http://java.sun.com/j2ee/j2sdkee/techdocs/guides/ejb/html/DevGuideTOC.html>) that provides a robust scalable system to academic staff and students. The main components that constitute CAMS are website management, workflow management system and authoring tools and web semantic management (Fig. 3).

- Website management is concerned with the design of website and its structure. In order to give a higher flexibility to online notes and a better management of website, it is crucial to separate educational content from presentation style making them device independent. It should allow designer to change the layout or display of the website by changing a style-sheet. By having device independent content, it is possible to extend distance education services to additional devices like Personal Digital Assistant (PDA), mobile phone, digital television and so on without affecting the content structure.
- Workflow Management System and Authoring Tools (WMSAT) are concerned with the content authoring process that includes the coordination of the tasks, the exchange of the data files, media information and task information among the members according to the predefined rules. A properly designed workflow management system and authoring tools will ensure the process of educational content production to move seamlessly through the "life cycle of online notes".

- Web semantic is concerned with the issues of data management. A proper management of data is very important for CAMS to adopt features like content exchanging, reusing or repurposing, sharing and searching capabilities. An effective method to manage and present data is to mark up web content using XML (<http://www.w3.org/XML>) and present the online notes using style language XSL (<http://www.w3.org/Style/XSL>). Metadata is the information about a data item that an agent will refer to when search service is requested. It holds information like title, keywords, date of creation, revision history, source, expiry date and so on. To allow users to browse and search for live and archived content through a default public interface, CAMS should have sophisticated metadata capabilities. The combination of XML/XSL and metadata will definitely yield a promising approach for web semantic management.

Implementation of CAMS: In this section, we will discuss the actual implementation of the CAMS including the programming languages and tools that we used, program platform, system architecture and the key components of CAMS. Table 1 summarizes the programming languages and developing tools used in the system.

Table 1: Programming Languages and Developing Tools Used

System Component	Language/Tool
Operating System Platform	Linux 7.2
Web Server	Apache
Application Server	Tomcat
Website Management Tools	Java
Work Flow Management and Authoring Tool	Java
Web Semantic	XML
Web Presentation	XSLT
Synchronization of Multimedia	SMIL
Database	Oracle
Online Study Notes	JSP, Java script, HTML
Streaming Platform	Real Media Streaming Server

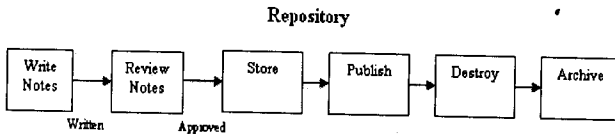


Fig. 1: Life Cycle for Online Education Notes

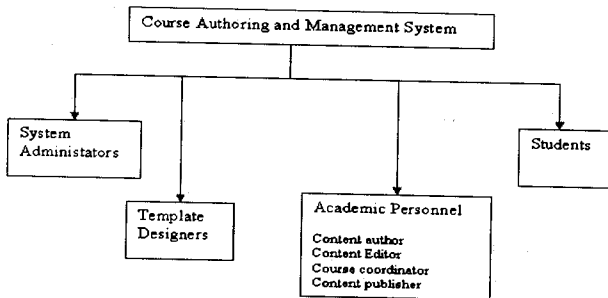


Fig. 2: Different user Levels in CAMS

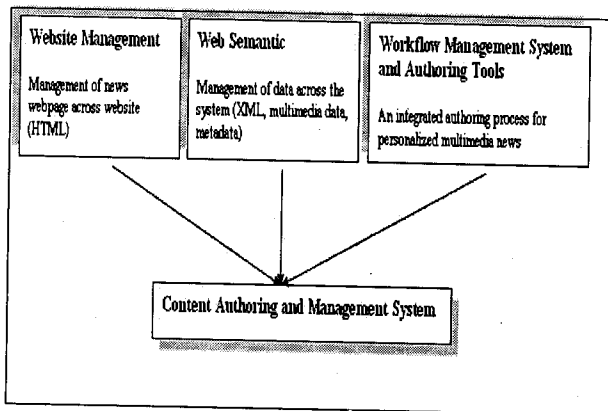


Fig. 3: Constituents of CAMS

CAMS is built on top of the tomcat application server and apache web server running on Linux 7.2 operating system. The reason for such a combination is that Tomcat is not as fast as Apache when dealing with static pages and also it is not as configurable and robust as Apache. Thus, we have decided to use Apache for serving the static online notes on the website and use Tomcat as a Servlet/JSP add-on for dynamic online notes. Linux 7.2 is chosen as it is a very stable platform that provides a scalable, multi-tasking, multi-user and a highly robust environment to CAMS. Server that runs on Linux platform can literally run for years without a crash. This is a desirable feature that a distance education program should possess.

The main components of CAMS such as web management tools, workflow management and authoring tools are built on the JavaTM 2 platform that makes CAMS a cross-platform portable and scalable system. As for the web semantic, XML is chosen to deal with the data management within CAMS that provides an effective method to manage the education content on the web. To make sure that a consistent look and feel across the entire website, XSL is used to present the web education content. The combination of XML/XSL will enable the separation of design from content allowing academicians to concentrate on producing study materials to the students with no botheration of how the content will be presented. At the same time, template designers or developers will be able to focus on the presentation of content without any concern for the content and its location in the site. Oracle is selected as the centralized database that serves as the "heart" of information management of online materials, students profile, online materials, tracking and versioning and other information within a distance education system. Student online notes is generated using JSP, Java script and HTML. However, for online notes that consists of multimedia elements, Synchronized Multimedia Integration Language (SMIL)

will be used to synchronize the different multimedia elements. These multimedia elements will be streamed across the Internet using the Real Media Streaming Server to the student.

System Architecture: CAMS is built using a 5-layered architecture shown in Fig. 4 that consists of the following layers: presentation layer, application logic layer, persistence layer, database layer and streaming layer. It helps organize content from inception through deployment and eventually, to archiving and deletion of education online notes notwithstanding time and location challenges. The presentation layer consists of dynamic HTML and content management tools which are composed from XML and XSL stylesheets and java servlets respectively. The application logic layer contains domain-objects and process-objects that perform operations on data-objects and provide data for presentation to management and authoring tools on the presentation layer. Online educational materials developed in our system are based on XML, XSL and XSLT (<http://www.w3.org/TR/xslt>) techniques, which are most suitable for description and presentation of hierarchical media structures. The persistence layer possesses the characteristics needed to read, write and delete objects to or from the database. The database layer provides the mechanism for storing news content and user profiles consistently by using a relational database model. Finally, a streaming server is used to deliver the personalized video content to the user. Real System Server Basic (<http://www.realnworks.com/products/servers/basic.html>) from Real Networks is used as a streaming server in our system because it supports SMIL (Lloyd Rutledge, 2001 and <http://www.w3.org/AudioVideo>) streaming.

Results and Discussion

Features in CAMS: This section describes the various components of CAMS and their features. These components are illustrated in Fig. 5.

Administration Module: Administration module will help the system administrators to set up and maintain CAMS that includes management of students, the definition of workflows, assignment of permissions and tools for accessing control.

Personal Workspace Module: Based on the type of user in the CAMS, academic people consisting of professors, lecturers, tutors and students will have a separate personalized workspace. Academicians will have different types of access control and tasks listed in their own workspace so as to create online notes for a certain chapter in a given time frame, to approve online materials produced by other colleagues, to create tutorial questions and so on. The students on the other hand will have their own workspace from which to read the online materials published by the faculty.

Searching Module: The searching module will help students to actively search for a particular online material that is published on the web. As for the academic staff, this module will help to search both the online and the archive repository for a certain material. This will ease the process of content repurposing and using it beyond the origin of its creation. For instance, the use of fundamental concepts in mathematics like differential equations can be found in engineering fields like circuit analysis. There is no need to reinvent the

wheels as far as the application of mathematical tools is concerned.

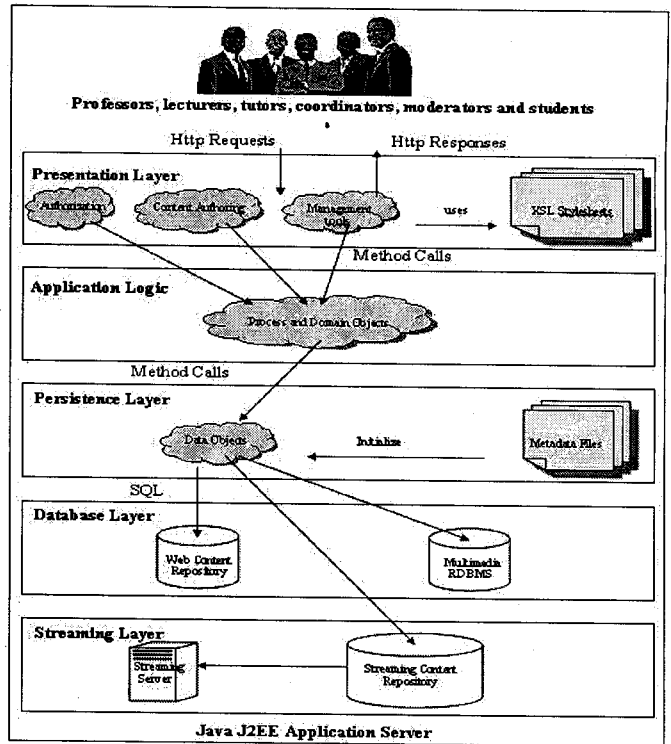


Fig. 4: System Architecture of CAMS

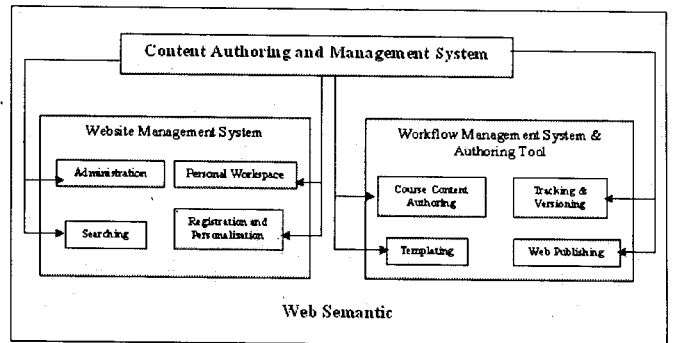


Fig. 5: Components of CAMS

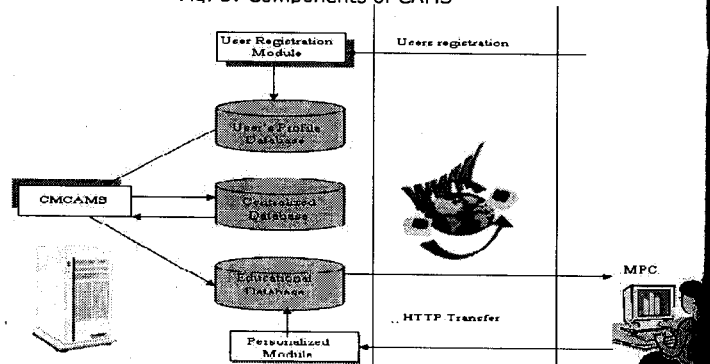


Fig. 6: Personalization Process for Online Educational Materials

Registration and Personalization Module: This module is responsible for registering the students in the course through the application. Personalization of online education materials is made possible through this registration module where student registers with the server by selecting the subjects of interest, bandwidth availability, level of difficulty and other relevant information (Fig. 6).

Multi-lingual Personalization: A live lecture will be encoded into video clip using the Real sure stream video encoder. Sure stream technology will vary its frame rate and quality of multimedia education content to suit student's internet connection speed ranging from 28.8K to hi-broadband. Thus, by using the sure stream technology we can surely extend the use of multimedia technology in distance education program to cater to the students in rural area, in which internet bandwidth is a major issue. Audio is separate out during the video encoding process while audio in other languages such as Malay, Mandarin and Tamil are to be encoded in the language module. The separation of video and audio elements is done such that a multi-lingual video lecture can be achieved by using the SMIL. Such a globalization steps will enable students from a multi-national country like Malaysia where Malays, Chinese and Indian are the main races, to learn more effectively in a distance education program. An educational multimedia content personalization system is illustrated in Fig. 7.

Workflow Management System and Authoring Tools (WMSAT): Workflow Management System and Authoring Tools (WMSAT) allows the faculty to assign academic staff to a small number of pre-define roles, such as "Course coordinator", "Content Author", "Content Editor" and "Layout Designer". Production process in a "life cycle of online notes" is formalized into a checklist consisting of a set of tasks using the WMSAT. It also allows course coordinator to specify some level of dependencies among the tasks to guide the order in which the production process should proceed. Once the tasks are assigned to the specific staff, then this staff will receive some form of notification within their workspace for reviewing and executing the assignments.

Course Content Module: This module is designed to help academicians to create online course material by following a step-by-step procedure, which includes: adding text, synchronized multimedia presentations, links, references, course syllabus, tutorial questions, lab sheets and so on. As an example, personalized presentation style is achieved by using the XSLT stylesheets. The stylesheets convert the multiple XML documents into SMIL files by selecting more or less automatically, the set of suitable presentation styles according to the student's needs as shown in Fig. 8. Then, the content author will fill up the template with a sequence of multimedia elements such as video lectures, powerpoint slides used in the lectures and audio of different languages to produce a global online education notes. Fig.9 shows a sample multimedia online notes composed using CAMS.

Templating Module: Template designers will work on this module to create different styles of presentation for normal online notes as well as the multimedia presentation (SMIL) layout. Many people are prone to think that web development is an art that deals with media manipulation and presentation. So, the web developer should be artistic. However, most of the academic personnel within a university generally are not artists. Thus, by having templating module, academicians need not have the artistic skills and yet can produce highly presentable education materials to the students by filling pre-defined templates that are

created by template designers equipped with artistic skills.

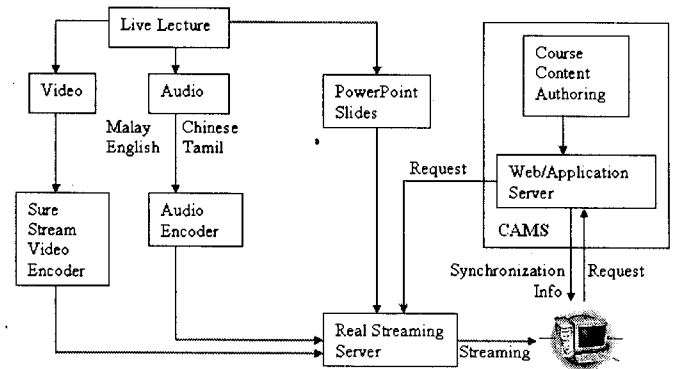


Fig. 7: Personalization System for Educational Multimedia Content

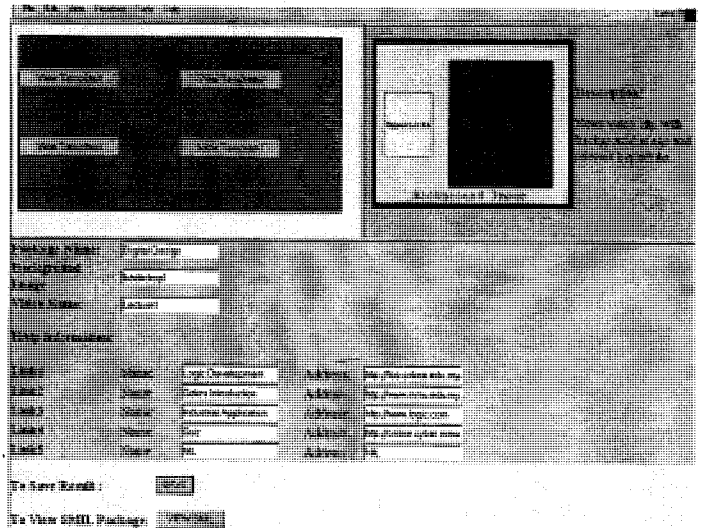


Fig. 8: Design of Multi-style Authoring System

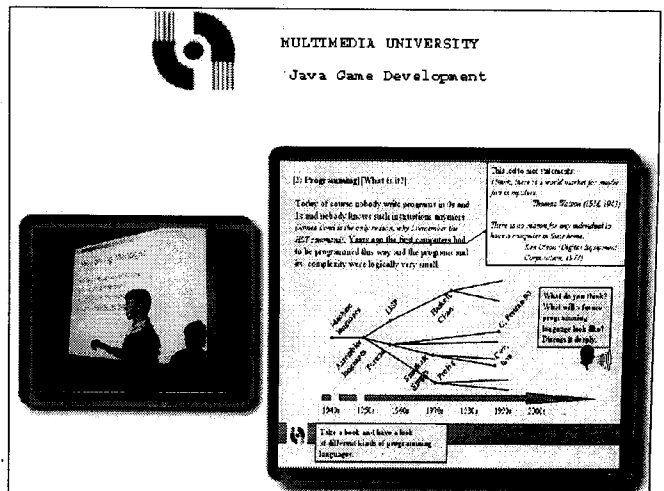


Fig. 9: A Composed Personalized Online Multimedia Notes

Web Publishing Module: Web publishing module will handle the issues of date of publication, expiry date, archiving and unpublished online materials.

Tracking and Versioning Module: Tracking and Versioning module will keep track of the educational content and associated information such as who created it, when was it created, when was it last updated and which version is active for publishing. The ability to track and reconstruct the changes in the online materials during the authoring process using the versioning information will increase the efficiency of the authoring system. Increase in efficiency across the production process means that the academic staff can do more with reduced wastage of effort resulting in cost saving.

Operation of Workflow Management System and Authoring Tools: Collaboration process between the course coordinators, professors, lecturers and tutors can be regarded as an important step that should exist to create quality online notes for distance education. Thus, CAMS provides a collaborative environment to allow course coordinator within a faculty to communicate and assign tasks to colleagues located either within the same building, campus or from a different university. The integrated workflow management system and authoring tool within CAMS allows collaboration of distributed teams and streamline the content authoring process by coordinating tasks and deadlines of many individuals. To illustrate further the operation of this system, we will explain a simple process that would be required for composing a chapter on "Engineering Design" lecture and notes and publish it online.

Course coordinator for the subject "engineering Design" could use CAMS to distribute specific tasks within an "online notes life cycle" to the relevant staff members to complete a chapter of online lecture and notes (Fig. 10). Let say a professor, upon receiving task from course coordinator could use CAMS to compose study materials by filling up predefined templates using text, images, lecture's video clips, audio clips, presentation slides, graphs, links, references and other information from a centralized database. When there is a need for special layout, course coordinator would entrust this task to layout developers to create customized presentation styles to the content author. To ensure a high quality and errors free online materials, once the first authoring process cycle is completed, another professor would be engaged by CAMS to review, revise and approve pre-published educational notes. Any changes made at this stage would be saved so as to retrieve whenever the operation of "roll-back" is needed. Finally, web publisher would schedule the deployment of the online notes to the students when requested by the subject coordinator and ensure that the notes on the site are current, appropriate and correct. Similarly, tutors would go through the same process to create tutorial questions online.

A Comparison of the Existing Systems: This section give a comparison between CAMS and the existing commercially available course management systems, WebCT that help universities in preparing courses for distance education.

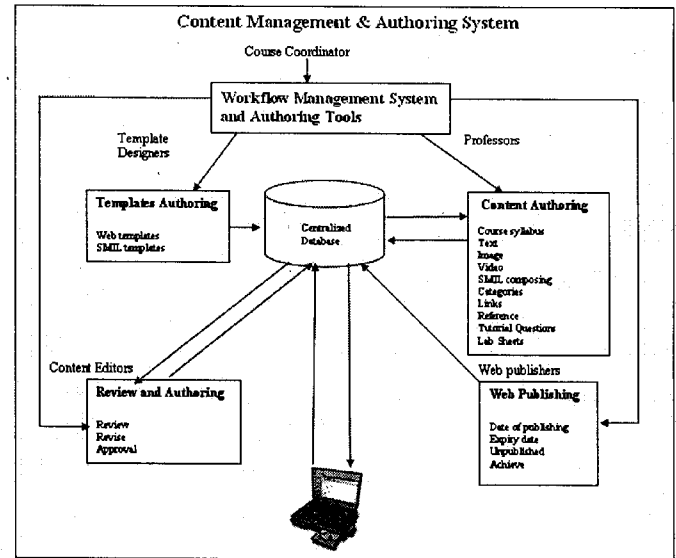


Fig. 10: Operations within a Workflow Management System and Authoring Tools

A Comparison of WebCT and CAMS

Table 2: Comparison of Features Between WebCT and CAMS

WebCT	CAMS
Course Builder	Course Authoring Module
Course Appearance	Templating Module
Manage Student	Administrator Module
Manage files	Web Management
Content Assistant	Searching Module
My WebCT	Personal Workspace
Course homepage	Personal Workspace
Syllabus	Content Categories
Content Module	Content Authoring tools
Assignments	Workflow Management System

Table 3: Comparison of Architecture Between WebCT and CAMS

	WebCT	CAMS
Programming platform	Java TM2 platform (J2EE)	Java TM2 platform (J2EE)
Database	Oracle	Oracle
Web/Application Server	BEA Weblogic Enterprise Server	Apache/Tomcat Server
Multimedia Streaming	Not Supported	Real Streaming Server

Table 4: Enhancement and Novel Features of CAMS

WebCT	CAMS
Authoring tools that support simple content like text and images	Authoring tools support simple content as well as multimedia content like lecture video clip, presentation slides that is synchronized by SMIL in an easy manner without the need of any programming skills
Language plug-in that support only content authoring environment	Personalization multimedia content in style, languages and bandwidth. Multimedia online notes in English, Chinese, Malays, and Indian and are stream automatically with appropriate internet connection speed to students according to their profiles.
Not Supported	A collaborating authoring environment that distributes authoring, reviewing and publishing works of online notes on the web among colleagues.
Not Supported	Content versioning and tracking

Conclusion

In this paper, we have presented the design of a 5-layered web application, built using J2EE i.e. Course Authoring and Management System (CAMS). The effectiveness of the CMCAMS is amply demonstrated with the development of an online education system. The framework used in this system has several novel features as compared to conventional approaches. These include a collaborative environment, a set of management tools for easy content authoring and user profiling and a method for quickly producing multi-style educational online notes for achieving personalization in online learning. The major contributions of this paper with regard to online learning, personalization and management can be summarized as:

1. Support for effective personalization of online multimedia content and presentation styles through the utilization of XML and XSLT techniques.
2. Separation of design from content, which allows educators to focus on content preparation rather than advanced HTML and SMIL programming.
3. Support for the re-use and re-purpose operations required for the same multimedia elements to be re-used in other online educational materials.
4. A web implementable CAMS.
5. Multilingual online multimedia content through SMIL presentation.
6. A collaborative workflow management and authoring system to ease the deployment of online notes. The application can be remotely used by the relevant personnel without any need of additional hardware or software. All that is required is a web-browser that supports SMIL streaming.

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