

## Chapter 1.57

# High Performance Publisher/ Subscriber Communication for Adaptive, Collaborative Web-Based Learning

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### **ABSTRACT**

The inability of current Internet-based learning systems to deal with different kinds of learners and the high cost of developing a new learning system are well-known problems in e-learning. To overcome these problems, we have designed a learning middleware suite, called the collaborative and sharable learning (CoSL) system. CoSL is a tool set for building e-learning systems and for developing course materials for an e-learning

environment. Given the geographic distribution of the components of a Web-based e-learning system, it is crucial to support fast communication between providers and consumers of e-learning course materials. In this chapter, a high performance Publisher/Subscriber communication system has been designed for real-time communication between participants. CoSL allows us to build and manage global real-time learning systems in a distributed and heterogeneous environment.

## INTRODUCTION

The Internet holds out great promise for revolutionizing education at every level. It combines the features of traditional distance learning methods with the best of multimedia technology. Thus, it eliminates the need to travel and the facility costs of a traditional school setting. While the immediacy of a classroom setting is still lacking in most e-learning systems, e-learning can be used to improve the quality of traditional instruction. Thus, students can be given individual access to simulation models and can email comments to classmates during an e-lecture. Technologies such as digital video will allow further improvements of distance education (Internet2). Many efforts have been made to build learning management systems (LMSs) to act as the core of online learning systems.

The major challenge for an Internet-based LMS is to provide integrated and cooperative means of access, because a global learning system is based on heterogeneous, distributed and autonomous data sources. Our solution to this problem is to provide educational middleware that allows the sharing and redistribution of learning objects, i.e., a sequence of course contents packaged as a module (Wiley), the personalization of delivery across a network and the collaboration with other institutions. Such an LMS allows one to plug-in executable contents (“Assignment Units”) on the learner’s interface and exchange data with that content, further enabling the dynamic presentation of course contents and the collection of student behavior data.

A typical LMS performs the tasks of managing online learning, keeping track of student progress and recording course completion (Thyfault, 2000). Adaptive learning environments usually support adaptive annotation, hiding and presentation of course contents, and generation of study problems of the appropriate difficulty (Beck, 1997). An adaptive educational system should incorporate pedagogical strategies, and apply them based on a

student’s psychological profile (Sternberg, 1997). However, our focus in this chapter is not on the pedagogical issues, but on the technological issues. No e-learning system will be well received, if its response times are inadequate. We describe an architecture called the collaborative and sharable learning (CoSL) system, which provides a way to build and manage global learning systems in a distributed and heterogeneous environment. The major contribution of this chapter is a high performance publisher/subscriber communication system, which was developed to support the communication within CoSL. XML-based interactions between components simplify heavy-duty data transformations required in a typical middleware system.

## COLLABORATIVE AND SHAREABLE LEARNING SYSTEMS

Our solution to the problems in distributed learning is to provide an educational middleware system. The CoSL system acts as the core of an infrastructure composed of local *learning component systems* (LCSs), *learning channel* and *learning middleware*. Figure 1 shows the CoSL framework. Our CoSL system has been designed following the paradigm of component-oriented development (D’Souza, 1999). Each learning component has contents, activities, rules, constraints and operations to deal with extension or modification of generic learning patterns (using composition and substitution). These components are autonomous with no need for a master component.

The objects within a component can be defined using a type model (D’Souza, 1999), which describes the state of the objects or the component(s). Each learning object is described with a type, attributes and associations, which represent relationships to other objects.

Learning components are considered to be self-contained and loosely coupled. A Publisher/Subscriber subsystem supports the communica-

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