Advanced Distributed Learning Initiative

Sharable Content Object
Reference Model (SCORM™)

Version 1.2

The SCORM Overview

October 1, 2001

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Sharable Content Object Reference Model
Version 1.2
The SCORM Overview

Available at ADLNet
(http://www.adlnet.org/)

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SECTION 1

The Sharable Content Object Reference Model (SCORM^{TM})

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1.1. About This Document

The Department of Defense (DoD) established the Advanced Distributed Learning (ADL) initiative in 1997 to develop a DoD-wide strategy for using learning and information technologies to modernize education and training and to promote cooperation between government, academia and business to develop e-learning standardization. The ADL initiative has defined high-level requirements ("-ilities") for learning content, such as content reusability, accessibility, durability and interoperability to leverage existing practices, promote the use of technology-based learning and provide a sound economic basis for investment.

This document defines a reference model for sharable learning content objects that meet these high-level requirements.

1.1.1. Description of the SCORM

The Sharable Content Object Reference Model (SCORM™) defines a Web-based learning "Content Aggregation Model" and "Run-time Environment" for learning objects. At its simplest, it is a model that references a set of interrelated technical specifications and guidelines designed to meet DoD's high-level requirements for Web-based learning content.

The work of the ADL initiative to develop the SCORM is also a process to knit together disparate groups and interests. This reference model aims to coordinate emerging technologies and commercial/public implementations.

A number of organizations have been working on different but closely related aspects of Web-base learning technology. While these evolving areas have recently made great strides, they have not been well "connected" to one another. Some emerging specifications are quite general, anticipating a wide variety of implementations by various user communities (e.g., those using the Web, CD-ROM, interactive multimedia instruction, or other means to deliver instruction); in others the specifications are rooted in earlier computer managed instruction (CMI) practices and require adaptation to Web-based applications.

The SCORM applies current technology developments – from groups such as the IMS Global Learning Consortium, Inc.[3], the Aviation Industry CBT (Computer-Based Training) Committee (AICC)[1] , the Alliance of Remote Instructional Authoring & Distribution Networks for Europe (ARIADNE)[12] and the Institute of Electrical and Electronics Engineers (IEEE) Learning Technology Standards Committee (LTSC)[2] – to a specific content model to produce recommendations for consistent implementations by the vendor community.

As shown in Figure 1.1.3a, all of the specifications and guidelines contained or referenced in this document can be viewed as separate "books" gathered together into a growing library. Nearly all of the specifications and guidelines are from other organizations. These technical "books" are presently grouped under two main topics: "Content Aggregation Model" and "Run-time Environment." The editors anticipate including additional specifications in future releases of the SCORM.

Please note that the scope of the SCORM is not all-inclusive. Many issues are not addressed by this version of the document. The authors will expand the scope of the reference model over time to reflect experience gained and lessons learned through implementation and deployment.

1.1.2. Status of this Document

The release of this version of the SCORM introduces the concepts of content packaging. The content package is an integral piece for meeting one of the overall requirements of the SCORM – 'interoperability'. This version of the SCORM also updates the meta-data used to describe learning content. The update has been made to reflect the latest meta-data specifications developed by the IMS Global Learning Consortium Inc[3] and the IEEE Learning Technology Standards Group[2] (LTSC). Since the release of the SCORM Version 1.1, researchers and early adopters have suggested a series of corrections, improvements and clarifications. These suggestions along with other changes are highlighted in section 1.1.6. A detailed listing of the changes is provided in Appendix C.

This version of the SCORM is considered stable, meaning that enough experimentation and testing has taken place to establish confidence that applications based upon the model can be implemented and tested for conformance. However, key aspects of the SCORM are likely to evolve and change based on future, industry-wide developments. This means that some aspects of the model may need to be "deprecated" (marked as soon to be discontinued) in favor of newer approaches soon to be developed. Deprecated functionality will be replaced with newer, improved functionality, with sufficient forewarning to permit clear and manageable migration to subsequent versions. There are no features or items marked for deprecation in this version of the SCORM.

1.1.3. Organization of the SCORM

As shown by Figure 1.1.3a, the SCORM treats each individually referenced specification as a separate "book". Future versions of the SCORM will likely add new specification "books" to the SCORM collection. With the release of this version, the SCORM has been divided into three books (described below) that correspond to sections 1, 2 and 3 of the previous version.

- Book 1 (this document) contains an overview of the ADL initiative, the rationale for the SCORM and a summary of the technical specifications and guidelines contained in the remaining sections.
- Book 2 (The SCORM Content Aggregation Model) contains guidance for identifying and aggregating resources into structured learning content. This book

describes a nomenclature for learning content, describes the SCORM Content Packaging and references the IMS Learning Resource Meta-data Information Model[22], itself based on the IEEE Learning Technology Standards Committee (LTSC) Learning Objects Metadata (LOM) Specification[21] that was developed as a result of a joint effort between the IMS Global Learning Consortium, Inc.[3] and the Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE)[12]. Together, these specifications form the SCORM Content Aggregation Model. These are shown as Book 2 specifications in Figure 1.1.3a.

- Book 3 (The SCORM Run-Time Environment) includes guidance for launching, communicating with and tracking content in a Web-based environment. This book is derived from the run-time environment functionality defined in AICC's CMI001 Guidelines for Interoperability[4]. ADL collaborated with AICC members and participants to develop a common *Launch* and *API* specification and to adopt the AICC Data Model for Web-based data elements. These are shown as Book 3 specifications in Figure 1.1.3a.

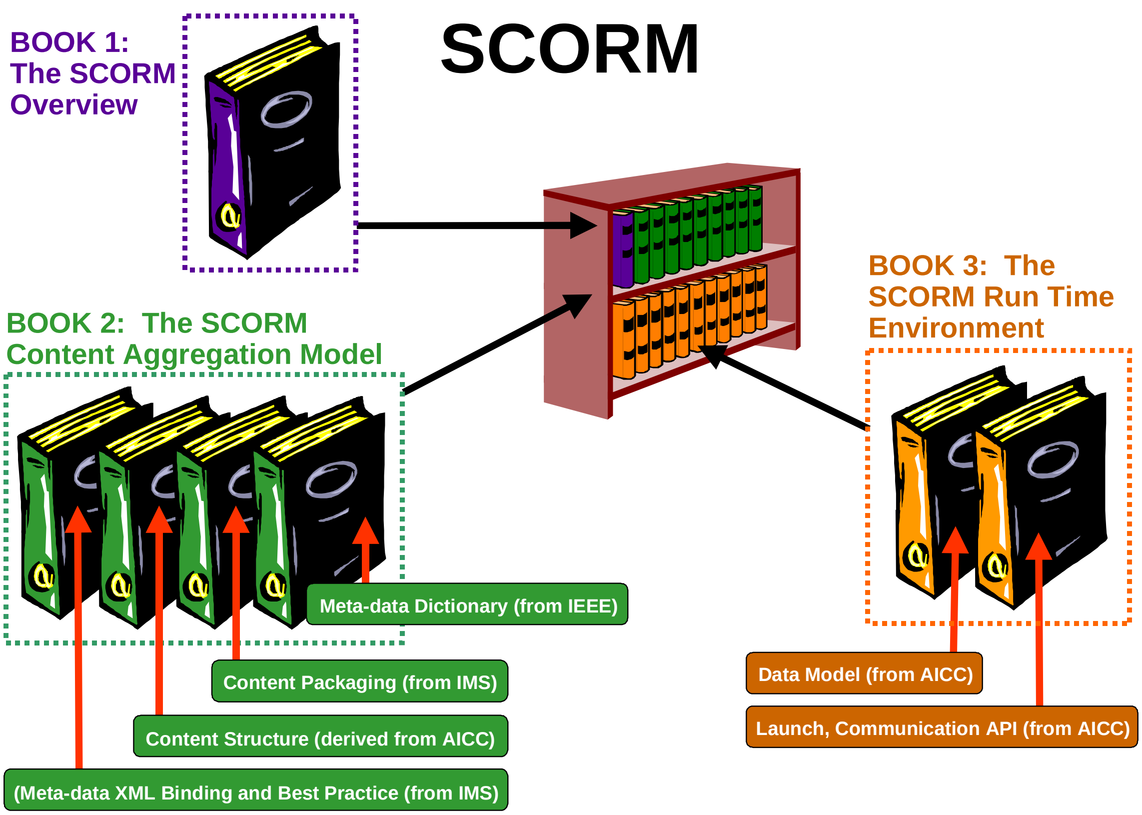

Figure 1.1.3a: The SCORM as a collection of specifications.

1.1.4. The SCORM and Other Standards Activities

As discussed throughout this document, the SCORM references specifications and guidelines developed by other organizations and adapted and integrated with one another to form a more complete and easier to implement model. ADL continues to work with these organizations and relies on their processes for specification development and industry ratification. ADL's role involves integrating and testing specifications, bridging the gap between early stage development and encouraging the adoption of specifications.

There are many organizations working on specifications related to e-learning, but four in particular are key. While ADL may not embrace all of the work from these organizations (some information is out of the scope of this document), these organizations play a vital role in the formation of next-generation learning technologies. ADL encourages you to become active participants in one or more of these organizations for future specification development. The organizations along with their respective contact information are listed in Table 1.1.4a.

Table 1.1.4a: ARIADNE, AICC, IEEE and IMS Contact Information

Organization	Contact Information	World Wide Web
Alliance of Remote Instructional Authoring & Distribution Networks for Europe (ARIADNE)[12]	Mme M. Rittmeyer or M. E. Forte Phone: +41-21 693 6658 / 4755 Fax: +41-21 693 4770 ariadne@ariadne-eu.org	http://www.ariadne.eu-org/
Aviation Industry CBT (Computer-Based Training) Committee (AICC)[1]	Dr. Scott Bergstrom, AICC Administrator Phone: (208) 356-1136 admin@aicc.org	http://www.aicc.org/
IEEE Learning Technology Standards Committee (LTSC)[2]	Robby Robson, Chair, IEEE LTSC Phone: (541) 754-1215 rrobson@saba.com	http://ltsc.ieee.org/
IMS Global Learning Consortium, Inc.[3]	For questions regarding Developers Network Membership: Marcia Rockwood, Director Operations Phone: (617) 571-7274 mrockwood@imsproject.org	http://www.imsglobal.org/

	For questions regarding Contributing Membership: Edward Walker, Ph.D., Chief Executive Officer ewalker@imsproject.org Phone: (978) 312-1082	

1.1.5. Thanks to Key Contributors

There are many people from industry, government and academia, working within AICC, IMS, IEEE and ADL, who have made important contributions to the evolution of the SCORM. While the editors cannot recognize everyone, certain individuals made pivotal contributions to the development process. ADL wishes to thank the following people whose assistance proved critical to the creation of the SCORM:

Eddy Forte and Eric Duval (ARIADNE): For their continuing contribution of Learning Object Metadata (LOM) specifications submitted from ARIADNE to IEEE since 1997.

Wayne Hodgins (Autodesk): For chairing the IEEE LTSC Learning Objects Metadata Working Group and bringing the meta-data specification to maturity.

Jack Hyde (AICC/FlightSafety Boeing Training International): For his efforts to evolve the AICC CMI guidelines to meet Web-based requirements and submitting the harmonized results to IEEE.

Claude Ostyn (Click2learn, Inc.): For developing a common launch and API Adapter proposal that formed the basis of the SCORM/AICC Run-time Environment.

Tyde Richards (IBM Mindspan Solutions): For designing the prototype XML Course Structure Format (CSF) representation that formed the basis of the SCORM CSF, and for his work to migrate the AICC CMI guidelines into the Web world.

Robby Robson (IEEE LTSC Chair/Saba): For harmonizing the work of IEEE with IMS, ARIADNE, ADL and others.

Ed Walker (IMS Global Learning Consortium, Inc.): For his work to include participation and inclusion of work from other groups and creating a collaborative environment within IMS.

Kenny Young (Microsoft): For working with ADL, AICC and IMS to develop a single industry content packaging scheme that harmonizes the requirements for all groups.

Again, these key names represent a fraction of the many contributors to the SCORM. All participants worked hard to create consensus and develop solutions to difficult problems. Hours of hard work and meetings continue to produce a substantial and growing body of work.

1.1.6. Overview of the SCORM Version Changes

1.1.6.1. SCORM Version 1.0 to SCORM Version 1.1

The SCORM entered a test and evaluation phase in January 2000. As expected, participants raised a number of questions and issues as they attempted to implement the SCORM Version 1.0. The SCORM Version 1.1 included corrections and improvements based on lessons learned from these early participants, while avoiding changing or expanding its scope from Version 1.0.

Most obvious of the many changes made to this document is the change in its title: Sharable *Courseware* Object Reference Model became Sharable *Content* Object Reference Model. This change was made to better reflect the fact that the specifications contained in and referenced by the SCORM apply to various levels of courseware components (e.g. content) as well as entire courses.

The SCORM Version 1.1 also reorganized the document in a more useful structure by presenting specifications into functional groups while keeping each specification in its own sub-section.

Other version 1.1 changes resulted from the collaborative efforts of the many organizations contributing to the development of the SCORM. During the test and evaluation phase of the SCORM Version 1.0, representatives of the IEEE Learning Technology Standards Committee (LTSC)[2] and the AICC[1] decided to streamline the AICC Computer Managed Instruction (CMI) specifications[4] that are being submitted to IEEE[2]. Streamlining resulted in the removal of a significant number of data elements in both the AICC Course Structure Format[4] and the AICC CMI Data Model[4] (on which the SCORM Run-time Environment Data Model is directly based). These decisions were based on a lack of widespread usage and in anticipation of more robust data models under development in several standards groups.

In an effort to keep industry practice consistent and harmonized, ADL deprecated the elements removed by AICC/IEEE in the SCORM Version 1.1. Work in progress within IEEE, AICC and the IMS Global Learning Consortium, Inc.[3] is expected to eventually replace the functionality removed from that version.

The data elements removed from the Content Structure Format (CSF) and data model were all “optional” in the original release; therefore, the editors anticipated minimal impact. Their removal was expected to reduce the amount of work and maintenance for implementers, especially Learning Management System (LMS) providers.

Aligning with the change from Sharable *Courseware* Object Reference Model to Sharable *Content* Object Reference Model, the *Course* Structure Format described in the SCORM Version 1.0 was changed to *Content* Structure Format. This change reflected the fact that aggregations of learning content smaller than an entire course can be represented by the SCORM.

The SCORM Version 1.1 also contained important improvements and changes made to the Application Program Interface (API) in the Run-time Environment that required code changes for both content and LMS implementations.

1.1.6.2. SCORM Version 1.1 to SCORM Version 1.2

This release of the SCORM adds specific SCORM Content Packaging application profiles derived from the IMS Content Packaging specification. These profiles map the Content Structure Format (CSF) from the SCORM Version 1.1 into the general IMS specifications.

This version of the SCORM also updates the meta-data section to refer to the latest work developed by the IMS Global Learning Consortium Inc[3] and IEEE LTSC[21]. The updates include changes to the information model and XML binding. This version of the SCORM also changed the names of the meta-data application profiles to better align with changes to the Content Aggregation Model for the SCORM Version 1.2 and in general with the IMS Content Packaging nomenclature.

The SCORM Version 1.2 continues to include corrections and improvements based on lessons learned from early participants, while avoiding changing or expanding its scope from Version 1.1.

A more detailed listing of the technical changes to the SCORM is summarized in Appendix C.

1.1.7. Ancillary Sample Software

The release of the SCORM Version 1.2 includes examples of code implementing aspects of the SCORM. These basic examples are provided to accelerate more sophisticated implementations. Those who review or use the code examples are encouraged to provide feedback to the ADL initiative concerning their experiences. They are also encouraged to develop additional or alternative code examples that may be shared with others. In this way the SCORM will become more complete and accurate, and test-development software will become more robust. For all ancillary samples please visit ADLNet at (http://www.adlnet.org/).

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1.2. The ADL Initiative

1.2.1. About the ADL Initiative

The Department of Defense (DoD) and the White House Office of Science and Technology Policy (OSTP) launched the Advanced Distributed Learning (ADL) initiative in November 1997. The purpose of the ADL initiative is to ensure access to high-quality education, training and decision aiding ("mentoring") materials that can be tailored to individual learner needs and made available whenever and wherever they are required.

This initiative is designed to accelerate large-scale development of dynamic and cost-effective learning software and to stimulate a vigorous market for these products in order to meet the education and training needs of defense and industry in the 21st century. ADL is developing a common technical framework for computer and Web-based learning that will foster the creation of reusable learning content as "instructional objects."

The ADL Strategy

- Advance the state of the art
- Enhance personnel productivity and effectiveness
- Link instruction and decision aiding
- Pursue emerging network-based technologies
- Facilitate development of common standards
- Lower development costs
- Promote widespread collaboration that satisfies common needs
- Enhance performance using next-generation learning technologies
- Work with industry to influence commercial off-the-shelf (COTS) product development

1.2.2. The ADL Mission

The mission of the ADL initiative is to provide high quality instruction and decision aiding anytime, anywhere and tailored to each learner's needs. Using technology to integrate and deliver sharable content may be the best means to reach this goal, but it is a means to an end. It is not the goal itself.

This document is also a means to an end. It specifies a technical methodology that will help achieve functional capabilities targeted by the ADL mission. The SCORM is a necessary, but by no means sufficient part of the success of the ADL initiative.

The ADL mission will only be satisfied with the provision of high-quality instruction and decision aiding available anytime, anywhere. High-quality instruction achieves its objectives dependably (for all students and users) and efficiently (with minimal costs and maximum effectiveness).

The ADL initiative assumes that dependable and efficient instruction and decision aiding will adapt itself to the unique needs, abilities, background, interests and cognitive style of each learner. It will tailor the content, pace, detail, difficulty, etc. of its presentations as needed by specific individuals at specific times.

Further, the instruction provided will be accessible anytime and anywhere. The Internet and World Wide Web make this level of accessibility possible. An assumption underlying the approach taken by the ADL initiative is that any instructional material made available for Web delivery can readily be delivered using other instructional technology.

1.2.3. The ADL Vision

The ADL initiative is preparing for a world where communications networks and personal delivery devices are pervasive and inexpensive, as well as transparent to the users in terms of ease of use, bandwidth and portability. The challenges in meeting the ADL mission are not then based on technology infrastructure *per se*. Instead, the task is to understand how to fully utilize the next generation technology infrastructure for learning anytime, anywhere.

ADL development envisions the creation of learning "knowledge" libraries, or repositories where learning objects may be accumulated and cataloged for broad distribution and use. These objects must be readily accessible across the World Wide Web or whatever forms our global information network takes in the future.

It is expected that the development of such repositories will provide the basis for a new instructional object economy that rewards content creators for developing high quality learning objects and encourages the development of whole new classes of products and services that provide accessible, sharable and adaptive learning experiences to learners.

The development of reusable, sharable learning objects is key to ADL's long-term vision. As shown in Figure 1.2.3a, once sharable learning objects exist and are commonly available, they can be assembled in real time, on demand and then delivered to learners as needed. Thus the ADL initiative is focused on the design of sharable learning content objects and the development of an instructional object economy.

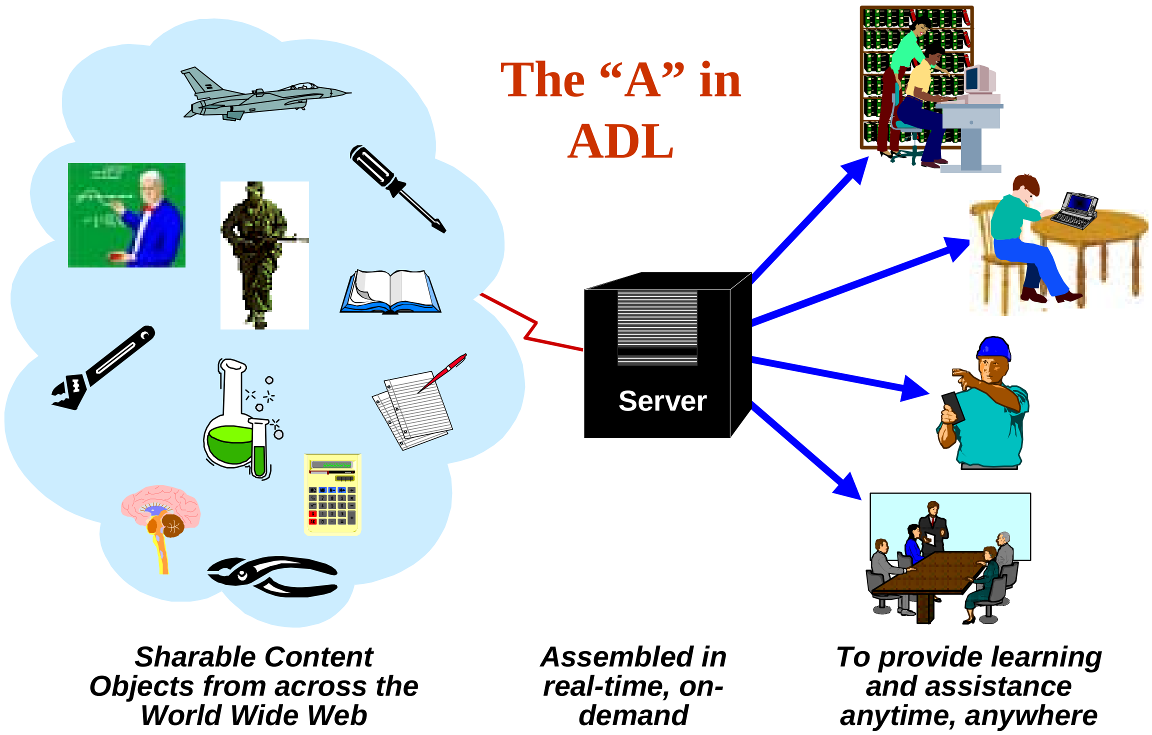

Figure 1.2.3a: Long term vision of the Advanced Distributed Learning initiative

1.2.4. The SCORM's Role in Fulfilling ADL's Vision

The SCORM constitutes an important first step toward liberating learning content objects from local implementations. It is intended to provide the technical means for content objects to be easily shared across multiple learning delivery environments.

The SCORM, however, does not solve all of the technical challenges that must be overcome to create a robust instructional object economy. Other efforts, built on the SCORM foundation but more directly concerned with instruction, will be required. The SCORM itself will continue to evolve and overcome technical issues and restrictions that impede achieving ADL's long-term vision.

1.2.5. The Advanced Distributed Learning Co-Laboratory

In 1999, the Department of Defense (DoD) established the Advanced Distributed Learning (ADL) Co-Laboratory[5] (Co-Lab) initially at the Institute for Defense Analyses (IDA)[6] in Alexandria, Virginia, to foster the collaborative research, development and assessment of the common tools, standards, content and guidelines for the ADL initiative. Executive Order 13111[7] tasked the DoD to take the lead in working with other Federal agencies, academia and industry to develop common specifications and standards for technology-based learning that could be used to support national education and training needs. The DoD was also tasked to provide guidance to other Federal agencies best practices in this area. As the focal point for the SCORM, the ADL Co-Lab provides a forum for collaborative exchange and technical support in developing and assessing prototype tools and learning content that observe the new and evolving specifications referenced by the SCORM.

The ADL Co-Lab concept is based on joint service and interagency collaboration and demonstration. The ADL Co-Lab houses a number of DoD service activities and operates as the organizational host for agency sponsors and project managers. This activity stimulates progress being made in knowledge management systems and technologies that enhance learning and performance across services and agencies through the coordination of their efforts. Figure 1.2.5a portrays the high-level ADL Co-Lab concept of operations.

Since the establishment of the ADL Co-Lab, the Department of Labor (DOL) and the National Guard Bureau (NGB) have joined the ADL Co-Lab as “contributing sponsors”. These organizations are leveraging resources and projects with the ADL Co-Lab and are in the process of moving their content into SCORM conformance.

To support specific ADL communities, two ADL Co-Lab nodes have been established in Orlando, Florida and Madison, Wisconsin. The Joint ADL Co-Laboratory[5] node in Orlando was established in October 1999 to promote collaborative development of ADL prototypes and ADL systems acquisitions, principally among DoD components and the military services. In January 2000, an independent Academic ADL Co-Laboratory[5] was established in partnership with the University of Wisconsin and the Wisconsin Technical College System to promote collaborative development, demonstration and evaluation of next-generation learning technologies that enable distributed learning, principally among academic institutions. All three ADL Co-Labs work together to share research, subject-matter expertise, common tools and course content through the virtual ADL Co-Lab Network.

ADL Co-Laboratory Concept of Operations

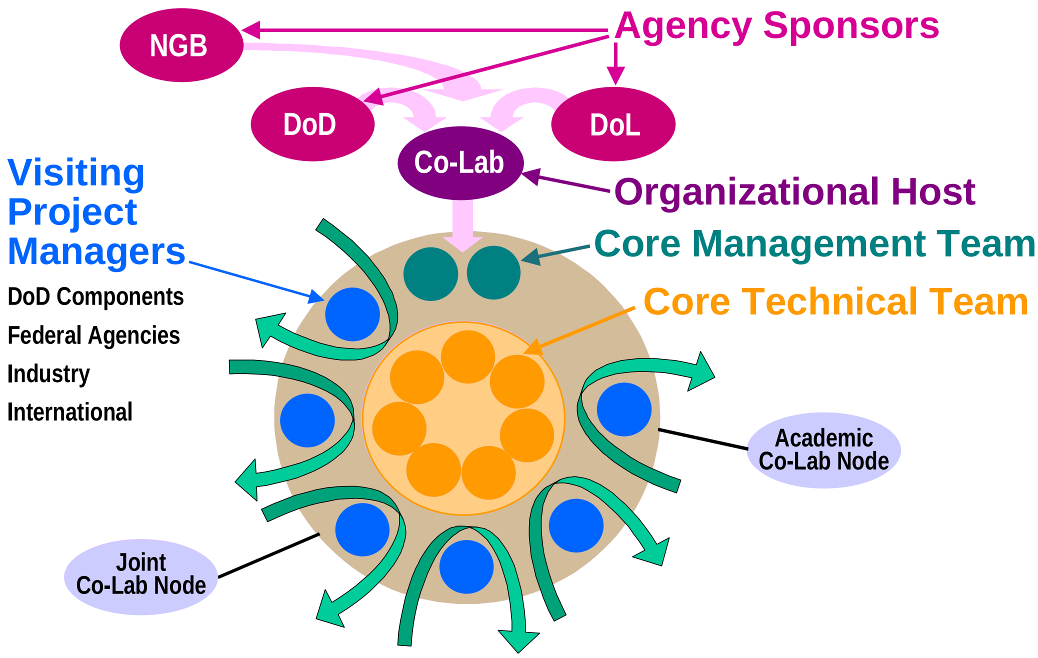

Figure 1.2.5a: ADL Co-Lab Concept of Operations

The ADL Co-Lab will help determine how learning technologies can be designed to bring about specific, targeted instructional outcomes reliably within as wide a range of instructional settings as possible. Other research areas include determining the most effective methods to:

- Tailor pace, content, sequence and style of instruction to the needs of individual learners – taking advantage of their strengths and concentrating on areas where they need help;
- Integrate technology within our existing instructional institutions and determine what changes are needed for these institutions to maximize return on investments in technology;
- Develop new instructional techniques, such as intelligent tutoring, tutorial simulations and networked simulation, that take full advantage of the capabilities technology brings to instruction;
- Assess the costs and effectiveness of instructional programs; and
- Measure and verify the capabilities and performance of learners.

The ADL Co-Lab also will provide an open environment for testing and evaluating learning technologies and content associated with distributed learning. It will foster the development, dissemination and maintenance of guidelines to support the DoD and other Federal agencies. These guidelines will include use of instructional development tools, design and development strategies and evaluation techniques. As such, the ADL Co-Lab will facilitate resource sharing across government, academia and industry.

The ADL Co-Lab will test and evaluate projects in order to determine whether they meet user requirements for reusability, accessibility, durability, interoperability and cost-effectiveness. Candidate projects for the ADL Co-Lab are those that:

- Demonstrate the ability to move Web-based content from one learning environment (learning management system) to another;
- Demonstrate the reuse of learning content "objects" across different platforms and learning environments;
- Provide searchable learning content across different learning environments or media repositories;
- Provide authoring tools for producing SCORM objects;
- Provide adaptable learning tools and content that can be tailored to the needs of the individual learner on the fly; and
- Support intelligent systems, intelligent tutoring and performance support capabilities.

The ADL Co-Lab is inviting government, academia and business participation at ADL Plugfest events that afford vendors and developers the opportunity to demonstrate the interoperability and reuse capability of ADL prototypes and to refine and update the SCORM. The ADL Co-Lab serves as a hands-on showcase for ADL demonstrations and products that meet the SCORM criteria. It also functions as a clearinghouse for distributed learning technologies, prototypes and projects. For more information, please visit ADLNet at, http://www.adlnet.org/.

1.3. Rationale for a Common Reference Model

A key ADL requirement for learning content is the ability to reuse instructional components in multiple applications and environments regardless of the tools used to create them. This requires, among other things, that content be separated from context-specific run-time constraints and proprietary systems so that it can be incorporated into other applications. Also, for reuse to be possible, content must have common interfaces and data. This document specifies a reference model that abstracts run-time constraints and defines a common interface and data scheme for reusable content.

1.3.1. The Need for Competency

Government, academia and industry are experiencing an unprecedented revolution in science and technology. This revolution and the advances it presents pose both significant challenges and opportunities. Organizations must adopt these advances and leverage them if they are to compete successfully in the 21st century. However, infusing technology in routine operations increases the demand for people who can use and maintain it competently. Despite the increasing presence of technology, competent human performance remains as essential as ever, and its ready availability is a matter of the first importance in all sectors of the economy.

Fortunately, technology also provides the means to meet the challenges it presents. As new instructional technologies emerge, they provide opportunities for universally accessible and effective lifetime learning. These technologies extend learning beyond the confines of traditional classrooms and campuses to encompass homes, community resources such as museums and libraries and workplaces. They extend beyond the traditional school-age population to support a nation of lifetime learners.

These issues have led to the vision that guides the ADL initiative's work.

1.3.2. The Value of Tailored Instruction

Empirical studies have raised national interest in employing education and training technologies that are based on the increasing power, accessibility and affordability of computer and networking technologies. These studies suggest that realizing the promise of improved learning efficiency through the use of instructional technologies—such as computer-based instruction, interactive multimedia instruction and intelligent tutoring systems—depends on the ability of those technologies to tailor instruction to the needs of individuals. In contrast to classroom learning, these approaches enable the pace, sequence, content and method of instruction to better fit each student's learning style, objectives and goals.

Research supports the intuitive appeal of technology-based instruction. The speed with which individuals can progress through instruction varies by factors of three to seven – even in classes of carefully selected students.[8] On average, a student in classroom instruction asks about 0.1 questions an hour.[9] In individual tutoring, students may ask or be required to answer as many as 120 questions an hour. The achievement of individually tutored students may exceed that of classroom students by as much as two standard deviations – an improvement that is roughly equivalent to raising the performance of 50th percentile students to that of 98th percentile students.[10]

The dilemma presented by individually tailored instruction is that it combines an instructional imperative with an economic impossibility. With few exceptions, one instructor for every student, despite its advantages, is not affordable. Instructional technology promises to provide most of the advantages of individualized instruction at affordable cost while maintaining consistent, measurable, high-quality content.

1.3.3. The Effectiveness of Technology-Based Instruction

Studies have shown that technology-based instruction may significantly reduce the costs of achieving a wide range of instructional objectives by 30-60 percent. These studies also reveal reduced time to achieve given instructional objectives (30 percent) or increased student skills and knowledge (30 percent) – depending on whether achievement or time is held constant.[11]

The value of these capabilities in reducing direct training costs is obvious. The savings accrued through better management of indirect costs such as productivity and time away from a job site are more difficult to quantify and capture, but are equally significant when determining the full return on investments in instructional technologies.

For instance, reducing by 30 percent the time to train just 40 percent of all DoD students in specialized skill training – which excludes other categories such as recruit training, pilot training, unit training and field exercises – could potentially save the DoD over $500 million annually.[11]

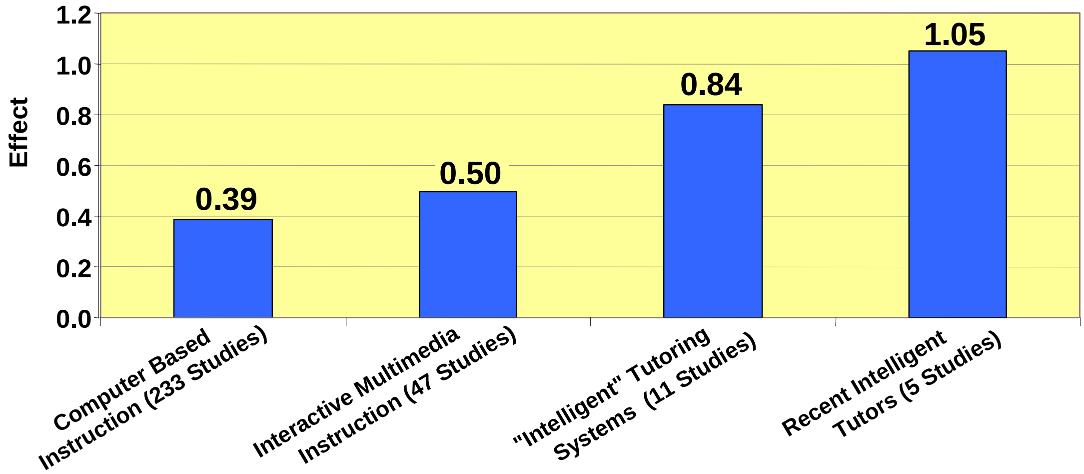

Figure 1.3.3a: Some Effect Sizes for Technology-Based Instruction[11]

Given these potential cost savings, it is reasonable to ask if training effectiveness must be compromised to achieve them. Figure 1.3.3a shows results aggregated from empirical comparisons of technology-based training with conventional classroom instruction. As the figure shows, 233 such studies of conventional computer-based instruction averaged an improvement in learning of about 0.39 standard deviations. Adding multimedia capabilities also adds effectiveness, raising the improvement to 0.50 standard deviations. Intelligent tutoring systems intended to more directly emulate one teacher interacting with one student and allowing either the student or the computer to ask questions, increases the improvement to 0.84 standard deviations. Some recent assessments of intelligent tutoring systems yielded improvements averaging about 1.05 standard deviations. We have yet to meet the 2.00 standard deviation challenge, but the trends are promising.

1.3.4. Distance Learning vs. Advanced Distributed Learning

The ADL initiative is based on various learning technologies. Examples of these technologies fall into two categories: *synchronous* and *asynchronous*.

Traditional distance learning programs emphasize *synchronous* learning technologies that are valuable in providing distance education and training in which students are physically separated from instructors. Synchronous technologies can be seen in virtual classroom initiatives, most of which are based on video teletraining and video teleconferencing. These technologies generally require students to gather together at one time in specific places, even though they are physically distant from the instructor. Many people refer to this type of synchronous technology as “Distance Learning”.

ADL emphasizes *asynchronous* technologies that can deliver instruction and mentoring without requiring students to gather in specific places at specific times – it concerns instruction and decision aiding, or 'mentoring', available anytime, anywhere. These technologies depend on computer technology for delivery and presentation. Examples include:

- Computer-Based Instruction
- Interactive Multimedia Instruction
- Intelligent Tutoring Systems
- Network Tutorial Simulation
- Web-Based Training

ADL generally refers to these as "Distributed Learning" technologies. Combining traditional computer-based instruction and interactive multimedia technologies with new Web-enabled intelligent tutoring and simulation capabilities are referred to as "Advanced Distributed Learning" technologies.

1.3.5. Promoting the Use of Technology-Based Instruction

There is, then, evidence that technology-based instruction can both lower training costs and at the same time increase instructional effectiveness for a variety of training objectives and programs. Yet its use is only beginning. For instance, data collected suggest that less than five percent of DoD training programs routinely use interactive training technologies[11]. Technology insertion, as is often the case with new applications, may depend on issues that are more structural and organizational than technological. Accounting categories, local incentives, personnel policies and training procedures must be changed to make best use of these new training capabilities.

Despite these difficulties, the benefits of technology-based instruction are increasingly recognized, and initiatives are being undertaken to increase its use, especially the ADL initiative.

1.3.6. The Need for a Reference Model

Successful implementation of ADL requires issuance of guidelines that are shared and observed by organizations with a stake in the development and use of instructional technology materials. The ultimate form and status of these guidelines remain to be determined. They may be international or national standards, agreed upon practices, recommendations, or *de facto* practices.

If these guidelines are to be successfully articulated and implemented, they must be based on a common "reference model". This model will not replace the detailed models of instructional system design or practices that have been devised and adopted by specific organizations such as those of instructional developers, tool developers or customers associated with particular industries or the DoD. Instead, the purpose of the reference model is to describe an approach to developing instructional material in sufficient detail to permit guidelines for the production of sharable content objects.

1.3.7. Reference Model Criteria

There are three primary criteria for such a sharable content objects reference model. First, as stated above, it must fully support articulation of guidelines that can be understood and implemented for the production of sharable content objects. Second, it must be adopted, understood and used by as wide a variety of stakeholders as possible, especially courseware and courseware tool developers and their customers. Third, it must permit mapping of any stakeholder's specific model for instructional systems design and development into itself. Stakeholders must be able to see how their own model of instructional system design is reflected by the reference model they hold in common.

Up-front investment is required to develop and convert training materials for technology-based presentation. These investment costs may be reduced by an estimated 50-80 percent through the use of sharable content objects that are:

- Durable – do not require modification as versions of system software change;
- Interoperable – operate across a wide variety of hardware, operating systems and Web browsers;
- Accessible – can be indexed and found as needed; and
- Reusable – can be modified and used by many different development tools.

Procedures for developing such content objects are within the state-of-the-art, but they must be articulated, accepted and widely used as guidelines by developers and their customers. These goals can only be achieved through collaborative development. Collaboration will also increase the number, quality and per unit value of content objects made available. Such collaboration requires agreement upon a common reference model. The Sharable Content Object Reference Model (SCORM) is intended to be such a model.

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1.4. Revolutionary Driving Forces

The ADL vision of a distributed and highly adaptive learning infrastructure is more than an idealistic goal. Major changes in computing and communications infrastructures are converging to produce revolutionary changes in learning systems technology. As shown in Figure 1.4a, this convergence is built upon nearly 50 years of experimentation and research along multiple evolutionary paths[13]. The historical factors shaping a potential convergence of multiple learning methodologies and technological capabilities help define near-term requirements for ADL and the SCORM.

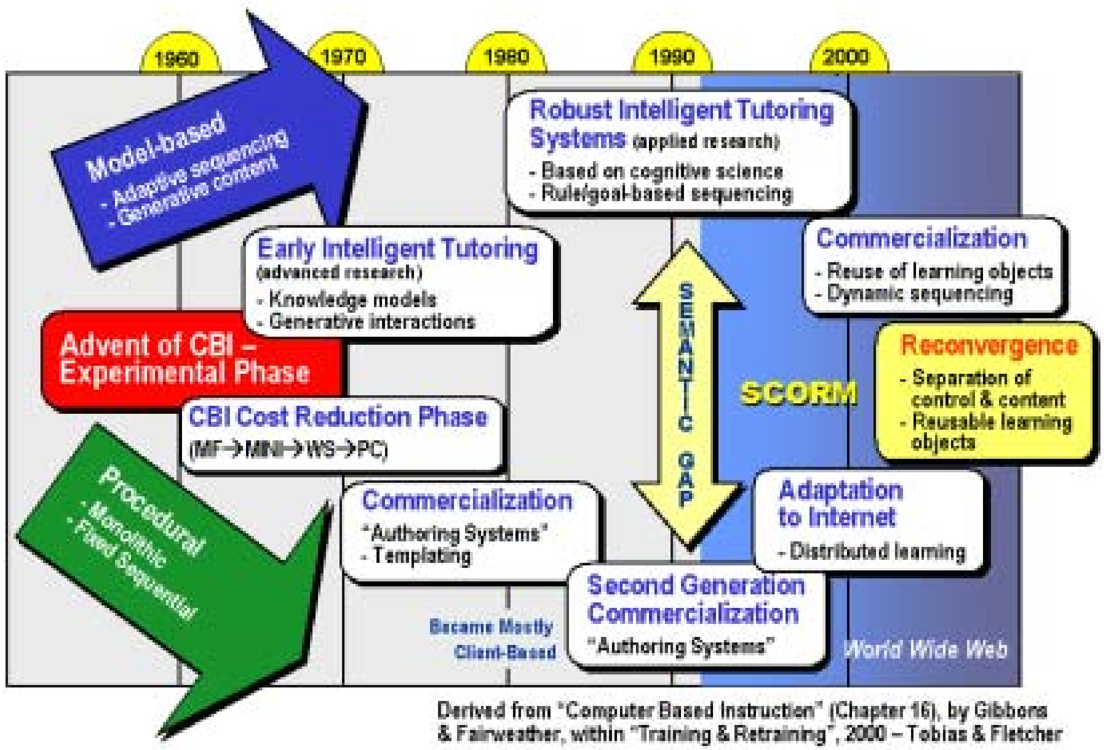

Figure 1.4a: Evolution of Computer-based Instruction and Intelligent Tutoring Systems technologies

1.4.1. Early Stages of Computer-Based Instruction

Psychologists and educators noted the instructional potential of computers soon after they were invented. Software programs codify process and procedures in an orderly and repeatable way. They can be used to assess the adequacy of learning and instructional theories (or just 'approaches') in two ways. First, if a learning or instructional theory can be represented in an algorithm, it is at least adequate and testable as a theory. Second, once such a theory is represented in software, the microsecond-to-microsecond data recording features of computers can be used to determine if the theory 'works' – if it represents learning or instructional reality. Early computer-based instruction (CBI) development focused on automating relatively simple notions of learning and instruction and then developing methods that proved to be effective[14]. This began a long chain of derivative work that influenced CBI content design methodology.

Following in the footsteps of computer science, the fledgling CBI community developed shorthand methods for coding successful “subroutine” programs. These evolved into instructional languages that imprinted upon computer science an instructional vocabulary understandable to training content developers. However, these languages were still very closely tied to the highly procedural nature and structure of early computing.

Costs were a major obstacle to widespread use of CBI. Much depended on the evolution of the underlying technology. Initially based on mainframe computers programmed in assembler language or primitive higher-order languages such as Coursewriter and early versions of Tutor, the migration and adaptation of CBI to minicomputers, workstations and later to personal computers, absorbed much of the energy of researchers and developers. With each succeeding generation of computing capabilities, new capabilities and features became available that could further automate instructional design and hide the complexities of programming.

1.4.2. Emergence of Intelligent Tutoring Systems

As shown in Figure 1.4a, beginning in the late 1960’s, and in parallel with CBI “engineers,” groups of researchers began to explore the greater potential of “information structure-oriented” approaches to represent human cognition and learning[15]. Rooted in early artificial intelligence studies, the study of how we learn, master skills and define subject domains eventually led to the development of a new approach we now call Intelligent Tutoring Systems (ITS).

‘Intelligent’ in the context of intelligent tutoring systems refers to the specific functionalities that are the goals of ITS development. These functionalities are distinct from those found in more conventional approaches to computer-based instruction. They require ITS to:

- Generate instruction in real time and on demand as required by individual learners, and
- Support mixed initiative dialogue, allowing free form discussion between the technology and the student or user.

This generative approach is also the goal of the Advanced Distributed Learning initiative, which is intended to combine the benefits of object oriented development and Web delivery with those of technology-based instruction to achieve its objectives.

Several factors have in the past hindered the development of ITS technologies[16]. First, the science of human cognition was relatively immature in the early days of computing – especially in terms of computer modeling. Second, complex modeling and rule-based systems require (then and now) considerable computing power. Subsequent advancements in both computer technology and cognitive science have provided essential support for the development of ITS technology[17].

ITS development will be further aided by content in the form of instructional objects that are readily accessible across the World Wide Web or whatever form our global information network takes. Once these objects exist, they can be identified, selected and assembled in real-time, on demand as suggested by Figure 1.2.3a. This generative work is the job of the server, represented as a black box in the middle of the figure. By importing 'logic' or instructional strategy objects, the server, may acquire the capabilities of intelligent tutoring/decision-aiding systems and accomplish these tasks.

The ADL initiative and the development of ITS, then, have a number of key goals in common:

- Both are generative in that they envision the development of presentations on demand, in real time;
- Both are intended to tailor content, sequence, level of difficulty, level of abstraction, style, etc. to users' intentions, backgrounds, and needs;
- Both have a stake in research intended to accomplish such individualization;
- Both can be used equally well to aid learning or decision making;
- Both are intended to accommodate mixed initiative dialogue in which either the technology or the user can initiate or respond to inquiries in natural language; and
- Both will benefit greatly from a supply of sharable instructional objects readily available for the generation of instructional (or decision aiding) presentations.

1.4.3. Evolutionary Split

Early on, computer-based instruction technologists split into two "natural" groups. The first can be described as applied scientists (engineers), and the second as advanced researchers. The engineers followed the evolutionary chain of computer development and exploited its advancements. This concept is shown in Figure 1.4a. The relatively crude early-stage instructional languages evolved into more complex development tools that abstracted the underlying implementations into more understandable learning constructs. Development costs were reduced, improved effectiveness was demonstrated and a sustainable industry of products and services was established[18].

Computer-based instruction technologists and engineers in the first group continued to refine tools to include complex instructional constructs in the form of instructional templates or frames. These templates descend directly from simpler programming techniques, but shield designers from the complexities of computer coding. They are, nonetheless, procedural in structure and nature.

As CBI tools matured, and personal computers proliferated, costs were dramatically reduced. Instructional content incorporated rich multimedia capabilities and authoring systems provided sophisticated feature sets. But these systems, which were predominantly client-based, produced monolithic and fairly rigid instructional content that was captive to the authoring tool environment. Instructional content and logic were tightly bound together.

Meanwhile, advanced researchers in the second group continued developing prototype Intelligent Tutoring Systems. Their concept of instructional content and design was fundamentally different from CBI tool designers. They sought to generate instructional experiences and presentations closely tailored to the needs of individual learners using sophisticated models of the learner, the subject matter and tutorial techniques. Such approaches tended to separate control logic from instructional content. The concept of dynamically assembling learning objects to meet specific learning objectives took root.

1.4.4. Impact of the Internet and the World Wide Web

The growth of the Internet and the World Wide Web interrupted the developmental progression of both CBI and ITS in unanticipated and unexpected ways. As it developed, the Internet provided a widely accessible communications structure built on common standards that provided easy access to information and knowledge.

Architecturally, the Web was antithetical to most CBI authoring system designs. Web content was platform neutral and stored and managed by a remote server, whereas most CBI content was stored and executed locally using private script languages processed by proprietary run-time software engines. Nonetheless, the CBI community was quick to see the long-term benefits of a distributed environment.

The first stages of conversion from stand-alone CBI to Web-based learning content were direct adaptations of existing products from CD-ROM to Internet delivery. The Internet was used initially as a replacement distribution medium. Content was still monolithic and held captive to the development environment. To render content, users were required to download proprietary browser plug-ins to process private formats. The brittleness of stand-alone CBI content persisted.[19]

Second-generation Web-based authoring systems began to more fully embrace the separation of content and control as the potential for robust server-based learning management systems. For the first time, mainstream CBI authoring tool developers began to embrace concepts similar to those in the ITS community. Reusable, sharable learning objects and adaptive learning strategies became common ground between the CBI and ITS communities.

1.4.5. Resulting New Technical Requirements

The World Wide Web has essentially reset the development agenda for both CBI and ITS development. There now exists an ever-improving communications and delivery platform for accessing knowledge. The technical standards that underlie the Internet turn out to work equally well locally, regionally and globally. Much of the development work once needed to adapt to the latest technology platform has been eliminated. The Web has become the universal delivery platform. Building upon existing Internet and Web standards and infrastructures has freed system developers to finally focus on next-generation learning architectures.

Researchers from both the CBI and ITS communities are focusing their attention on similar issues:

- Defining reusable learning objects
- Developing new content models
- Developing learner assessment models
- Creating new models for sequencing content
- Creating learning "knowledge" repositories.

Each of these topics drives the requirements for new standards work that will build upon and expand existing work such as the SCORM.

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1.5. Introduction to the Sharable Content Object Reference Model

This section provides a high-level overview of the scope and purpose of the Sharable Content Object Reference Model (SCORM). Subsequently, sections two and three define additional technical details of the model.

1.5.1. High-Level Requirements

The SCORM document frequently references high-level ADL requirements. The definitions below describe the high-level requirements the SCORM expects to eventually enable:

Accessibility: the ability to locate and access instructional components from one remote location and deliver them to many other locations.

Interoperability: the ability to take instructional components developed in one location with one set of tools or platform and use them in another location with a different set of tools or platform. *Note:* there are multiple levels of interoperability.

Durability: the ability to withstand technology changes without redesign, reconfiguration or recoding.

Reusability: the flexibility to incorporate instructional components in multiple applications and contexts.

These can be restated as:

- The ability of a Web-based Learning Management System (LMS) to launch content that is authored by using tools from different vendors and to exchange data with that content;
- The ability of Web-based LMS products from different vendors to launch the same content and exchange data with that content during execution; and
- The ability of multiple Web-based LMS products/environments to access a common repository of executable content and to launch such content.

The key function of an LMS in the ADL context, then, is to manage content objects.

1.5.2. Web-Based Design Assumption

The SCORM assumes a Web-based infrastructure as a basis for its technical implementation. ADL made this assumption for several reasons:

- Web-based technologies and infrastructure are rapidly expanding and provide a mainstream basis for learning technologies.
- Web-based learning technology standards do not yet exist in widespread form.
- Web-based content can be delivered using nearly any medium (e.g., CD-ROM, stand-alone systems and/or as networked environments).

This approach embraces industry's transition to common content and delivery formats. Computer operating system environments now natively support Web content formats. The trend is toward the use of common formats that can be used locally, on local intranets or over the Internet. The SCORM extends this trend to learning technologies.

1.5.3. Describing "Learning Management Systems"

Learning Management System (LMS) is a catchall term used throughout this document. It refers to a suite of functionalities designed to deliver, track, report on and manage learning content, student progress and student interactions. The term LMS can apply to very simple course management systems, or highly complex enterprise-wide distributed environments. A highly generalized model showing potential components or services of an LMS is shown in Figure 1.5.3a.

Many participants in the development of learning technology standards now use the term LMS instead of "computer managed instruction" (CMI) so as to include new functionalities and capabilities not historically associated with CMI systems. These include, among other services, back-end connections to other information systems, complex tracking and reporting, centralized registration, online collaboration and adaptive content delivery – all services required for student progress management.

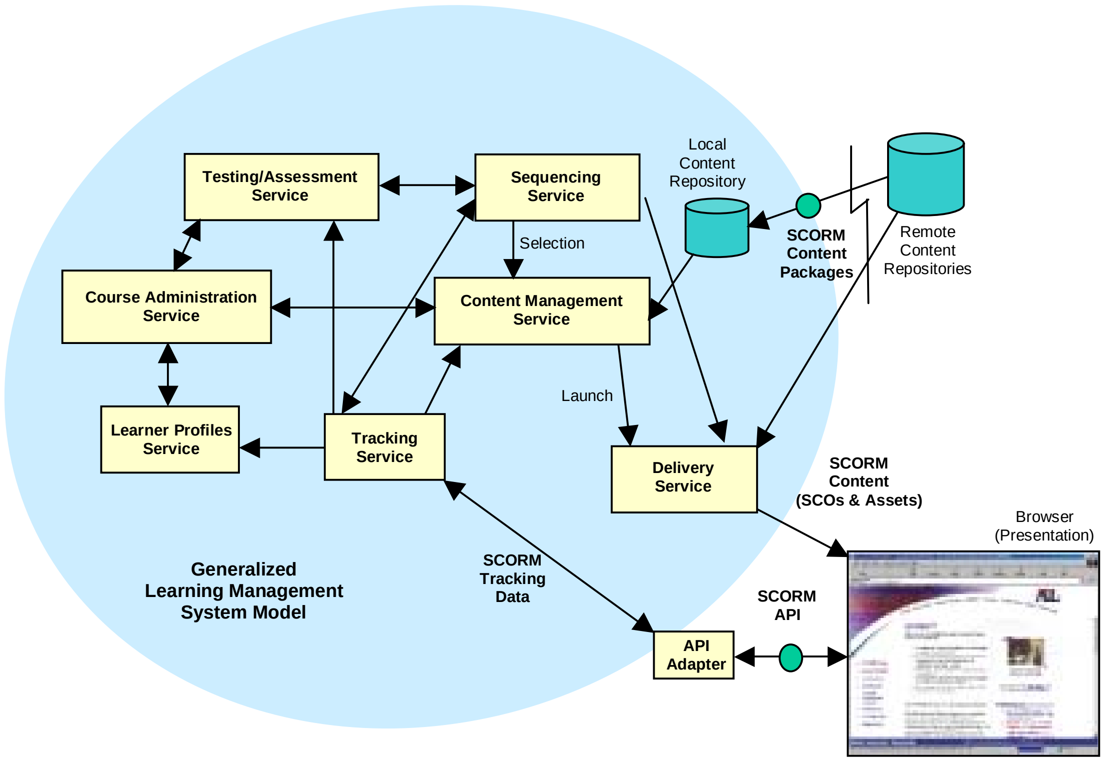

Figure 1.5.3a: Highly generalized model of a "Learning Management System" (LMS) as a suite of services that manage the delivery and tracking of learning content to a learner. The SCORM does not specify functionality within the LMS.

The term LMS is now being used as a superset description of many possible capabilities. Within the SCORM context, implementations are expected to vary widely. The SCORM focuses on key interface points between content and LMS environments and is silent about the specific features and capabilities provided within a particular LMS.

In the SCORM, the term LMS implies a server-based environment in which the intelligence resides for controlling the delivery of learning content to students. In other words, in the SCORM, the LMS has the ability to determine what to deliver and when, and tracks student progress through the learning content.

The SCORM supports the notion of learning content composed from relatively small, reusable learning resources aggregated together to form units of instruction such as courses, modules, chapters, assignments, etc. By themselves, learning resources have no specific context. When combined with other learning resources, the aggregation provides the context and allows an LMS to manage the learning experience. Resources can thus be reused in multiple contexts.

This means that learning resources do not determine by themselves how to sequence/navigate through an aggregation representing a unit of instruction. Doing so would require that learning resources contain information about other learning resources within an aggregation. Instead, sequencing/navigation is determined by rules defined within the aggregation and interpreted by the LMS. The LMS merely processes the externally defined rules and itself has no knowledge *per se* about how the content is organized except through the importation of rules defined in content packages. This allows the content designer/developer to specify sequencing attributes and rules and navigation behavior while maintaining the possibility of reusing learning resources within multiple aggregation contexts.

1.5.4. Tracking the Learner

Learner tracking features of traditional Computer Based Training (CBT) and Web Based Training (WBT) systems provide the pedagogical baseline for building adaptive learning environments. Historically, CMI has provided CBT systems with the capability to track learner interactions with the instructions albeit in a proprietary closed, tool-specific manner. Web-based learning systems build on CMI capabilities for tracking learner interactions while eliminating the proprietary and tool-specific hindrances.

Web-based learning systems differ from most Web site architectures in one important aspect. Most Web sites deliver content essentially one-way: from the server to the user. Occasionally information is entered by the user, for example when ordering something online, which is then posted back to the server. But for the most part, Web servers do not keep track of what the user is doing within the content until a specific request is made.

An LMS, on the other hand, must track learner progress and assess mastery. This involves gathering student profile information, delivering content to the learner, monitoring key interactions and performance within the content and then determining what the student should next experience.

Simple Web sites lack the means to track student progress consistently. Creating Sharable Content Objects that are trackable requires a standard model of the information being tracked. The Run-time Environment in Section 3 provides the mechanisms for communicating this kind of learning tracking in a standardized way.

1.5.5. Toward Adaptive and Intelligent Tutoring

The development of small, reusable and interoperable pieces of learning content, and the shift of control flow from embedded within learning resources to an external representation which can be processed by the LMS, establishes the basis for entirely new learning technologies.

The most obvious benefits of sharability and reuse are the possibility of large content repositories and the development of a new “content economy” where Sharable Content Objects are traded widely.

An even more interesting prospect is the development of complex learning management systems that can assemble, reorder and redefine learning content to fit the real-time needs of the learner. Unfortunately, the lack of reusable and re-sequenceable content has delayed this vision from becoming reality. The SCORM’s specific purpose is to provide a starting point for the next generation of advanced learning technologies that can be highly adaptive to the learner's individual needs.

1.5.6. Overview of the SCORM

The following describes a brief high-level summary of the SCORM. This section also presents an overview of the SCORM Content Aggregation Model and Run-Time Environment.

1.5.6.1. Overview of the SCORM Content Aggregation Model

The purpose of the SCORM Content Aggregation Model is to provide a common means for composing learning content from discoverable, reusable, sharable and interoperable sources. The SCORM Content Aggregation Model further defines how learning content can be identified and described, aggregated into a course or portion of a course and moved between systems that may include Learning Management Systems (LMS) and repositories. The SCORM Content Aggregation Model defines the technical methods for accomplishing these processes. The model includes specifications for aggregating content and defining meta-data. Book 2 provides a description of the SCORM Content Aggregation Model.

1.5.6.2. Overview of the SCORM Run-Time Environment

The purpose of the SCORM Run-time Environment is to provide a means for interoperability between Sharable Content Object-based learning content and Learning Management Systems. A requirement of the SCORM is that learning content be interoperable across multiple LMSs regardless of the tools used to create the content. For this to be possible, there must be a common way to start content, a common way for content to communicate with an LMS and predefined data elements that are exchanged between an LMS and content during its execution. The three components of the SCORM Run-Time Environment are defined in this document as Launch, Application Program Interface (API) and Data Model. The details of these elements of the SCORM Run-time Environment are described in Book 3.

1.5.7. Future Scope of the SCORM

Discussions are underway within many standards organizations regarding "next generation" Web-based learning architectures. These discussions are expected to eventually result in implementable specifications.

Listed below are examples of new capabilities that are candidates for the SCORM Version 2.0 and beyond:

- Designing new run-time and course data model architectures

- Incorporating simulation objects
- Incorporating electronic performance support objects
- Implementing SCORM-based intelligent tutoring capabilities
- Designing a new content model
- Incorporating gaming technologies.

The exact scope and timetable for the SCORM Versions 2.x are not yet defined. These examples are candidates that will be discussed and debated over the next year or more. Visit ADLNet (http://www.adlnet.org/) for information about ongoing developments.

1.6. Conformance Testing

The ADL Co-Laboratory[5] developed the SCORM conformance test software, procedures and supporting documents. The test software may be downloaded from ADLNet (http://www.adlnet.org/).

In addition, ADL is developing a testing certification process for organizations that wish to provide a testing service for their community of interest. Visit ADLNet for developments concerning the certification process.

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APPENDIX A
Acronym List

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Acronym Listing

ADL	Advanced Distributed Learning
AICC	Aviation Industry CBT Committee
API	Application Program Interface
ARIADNE	Alliance of Remote Instructional Authoring & Distribution Networks for Europe
ASCII	American Standard Code for Information Interchange
AU	Assignable Unit
AWT	Abstract Window Toolkit
CBI	Computer-Based Instruction
CBT	Computer-Based Training
CDATA	Character Data
CMI	Computer Managed Instruction
COTS	Commercial Off-The-Shelf
CSF	Content Structure Format
DC	Dublin Core
DoD	Department of Defense
DOL	Department of Labor
DTD	Document Type Definition
HTML	HyperText Markup Language
HTTP	Hypertext Transfer Protocol
IDA	Institute for Defense Analyses
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
ITS	Intelligent Tutoring Systems
LMS	Learning Management System
LOM	Learning Objects Metadata
LTSC	Learning Technology Standards Committee
MIME	Multipurpose Internet Mail Extensions
NGB	National Guard Bureau
OSTP	Office of Science and Technology Policy
PCDATA	Parsable Character Data
SCO	Sharable Content Object
SCORM	Sharable Content Object Reference Model
URI	Universal Resource Identifier
URL	Universal Resource Locator
W3C	World Wide Web Consortium
WWW	World Wide Web
XML	eXtensible Markup Language

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APPENDIX B
References

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Includes: IMS Learning Resource Meta-data Information Model, IMS Learning Resource Meta-data XML Binding Specification, and IMS Learning Resource Meta-data Best Practice and Implementation Guide
Available at: http://www.imsglobal.org/.

23. ISO 639: This is an international standard for the representation of languages. Version 1 uses two-letter language codes, e.g. 'en' for English, 'fr' for French, 'nl' for Dutch, etc. These language codes are a basis for the IETF registry of language tags, as specified in RFC 1766: Tags for the identification of languages.
Available at: http://www.iso.ch/.

24. ISO 3166: This is an international standard for the representation of country names, e.g. 'BE' for Belgium, 'CA' for Canada, 'FR' for France, 'GB' for United Kingdom, 'US' for United States, etc.
Available at: http://www.iso.ch/.

25. vCard: This standard defines how contact details for people and organizations can be represented.
Available at: http://www.imc.org/pdi/.

26. ISO 8601: This is an international standard that specifies numeric representations of date and time.
Available at: http://www.iso.ch/.

27. World Wide Web Consortium (W3C). http://www.w3c.org/
Includes: Universal Resource Locator, Universal Resource Identifier, Extensible Markup Language Version 1.0, Document Object Model (DOM) Specification.

28. Dublin Core Metadata Initiative. http://www.dublincore.org/.

APPENDIX C
Revision History

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Revision History

Version	Release Date	Affected areas	Comments
1.2	01-Oct-2001	1.1.2 Status of Document	Updates to include the latest status of the SCORM Version 1.2. Changed to include IMS Content Packaging Specifications and IMS Learning Resource Meta-data Specifications.
1.2	01-Oct-2001	Figure 1.1.3a	Updates to include Content Packaging book, removal of the Content Structure Format book and change to the name of the Meta-data XML Binding book. Changes to Section 1.1.3 to reflect SCORM being broken up into separate books.
1.2	01-Oct-2001	1.4.2 Emergence of Intelligent Tutoring Systems	Added more content describing the emergence of ITS and how it fits in with ADL..
1.2	01-Oct-2001	1.1.6.2 SCORM 1.1 to SCORM 1.2	Added overview of changes section.
1.2	01-Oct-2001	Figure 1.5.3a	Updated Generalized Learning Management System Model
1.2	01-Oct-2001	General	Grammar and style refinement.