Choosing a Learning Management System

Advanced Distributed Learning (ADL) Co-Laboratories

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Table of Contents

1. Purpose and scope of this paper 6

2. Overview 6

2.1 What is an LMS? 6

2.2 How widely are LMSs used? 8

2.3 What are the benefits of using an LMS? 9

2.4 Types of general learning goals managed by LMSs 9

2.5 Who uses LMSs and why? 10

2.6 The importance of choosing the right LMS 12

3. Process for choosing an LMS 12

4. Categories and examples of systems to deliver and manage learning 15

4.1 Learning Management Systems (LMSs) 16

4.2 Learning Content Management Systems (LCMSs) 18

4.3 Course Management Systems (CrMSs) 20

4.4 Virtual Learning Environments (VLEs) 22

5. Special features and issues to consider 23

5.1 LMS skins and templates 23

5.2 Pricing models 23

5.3 Open-source or freeware solutions 24

5.4 Government off-the-shelf (GOTS) solutions 26

5.5 Offline player capability 26

5.6 Security considerations for LMSs 27

5.7 Hosted solutions 28

5.8 The cross domain issue 30

5.9 Special requirements for U.S. DoD 31

5.10 Test and staging environments 32

5.11 Standards support 32

5.11.1 SCORM 32

5.11.2 Section 508 35

5.11.3 Aviation Industry CBT Consortium (AICC) 35

5.11.4 Standards for metadata 36

5.11.5 Common Cartridge® 36

5.11.6 QTI® 36

5.11.7 Training and Learning Architecture (TLA) 36

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5.12 Internal assessment authoring 37
5.13 The path of least resistance 38
5.14 Aligning staff and processes to system capabilities 38

6. Criteria for assessing quality and suitability of LMSs 38

6.1 Popularity of features and capabilities 56

7. Emerging trends in LMSs 57

7.1 Support and optimization for immersive learning technologies 57
7.2 Support and optimization for social media 58
7.3 Open architectures 61
7.4 Adding authoring capabilities 61
7.5 Extended enterprise learning 61
7.6 Instantiation for individual business units 61
7.7 Adding knowledge management architecture and capabilities 62
7.8 Support for team-based learning 62
7.9 “Gadget”- based interface 62
7.10 Adding talent management architecture and capabilities 63
7.11 Adding competency analysis tools 63
7.12 Component-based architecture 64
7.13 Multimedia LMS (MLMS) 65
7.14 Video conferencing integration 65
7.15 Search-based learning 66
7.16 Content delivery networks (CDNs) 66
7.17 Support for mobile learning 66
7.18 LMS as web services – is the traditional LMS dead? 67

8. For more information about LMSs 69

9. References cited in this paper 70

Appendix 72

A. Sample System Requirements Matrix 73
B. Sample System Features Rating Matrix 74
C. Examples of LMSs Used in the Federal Government and Social Media Integration 76
D. Examples of Virtual Worlds Used in the Federal Government that Feature LMS Integration 78
E. Diagram of Generalized LMS Architecture (including SCORM Elements) 80

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F. Security Considerations for DoD LMSs.....81
G. Sources of Possible Requirements for U.S. DoD LMS Acquisitions and Installations 82
H. Update on the SCORM Certification Program for LMSs 83
I. Additional criteria for assessing quality and suitability of LCMSs 83

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1. Purpose and scope of this paper

The purpose of this paper is to help those involved in the process of choosing a learning management system (LMS) to make an informed decision. The paper presents a range of considerations for choosing a system; it does not contain a comprehensive survey of available systems on the market, nor does it contain a comparative rating or evaluation of products, and should not be construed as such. For more in-depth information about systems and their features, see the references in *8. For more information about LMSs* or consult the vendors. ADL presents this paper merely as a guide to the issues, opportunities, and processes that should be considered in choosing a system.

Although this paper is focused on LMSs, we give some consideration to the broader scope of learning-related systems: course management systems (CrMSs), learning content management systems (LCMSs), and virtual learning environments (VLEs). You must account for these in the process of choosing a system to manage and deliver your learning, since you must first determine the high-level, basic functionality you need; if you need your system to manage instructor-led training classes, or include authoring capabilities, one of these systems might be a better choice than an LMS. In an effort to include the total decision process and options available, we present high-level descriptions of these systems in this paper, although we are mainly focused on systems that are designed to deliver and manage asynchronous e-learning (this is the traditional scope of LMSs).

In line with our mission to promote reusability and interoperability in e-learning, ADL recommends systems with built-in features that allow managing and delivering SCORM®-conformant e-learning. Acquiring a system that does not support e-learning that is interoperable or reusable can be a significant business risk. You can find SCORM considerations for LMSs in *5.11.1 SCORM*.

2. Overview

2.1 What is an LMS?

The Learning Systems Architecture Lab at Carnegie Mellon stated that, "A Learning Management System (LMS) is a software package used to administer one or more courses to one or more learners. An LMS is typically a web-based system that allows learners to authenticate themselves, register for courses, complete courses and take assessments" (LSAL, 2004 in Gallagher, 2007).

To expand on this definition, LMSs are enterprise level, server-based software systems used to manage and deliver (through a web browser) learning of many types, particularly asynchronous e-learning. They generally also include the capability of tracking and managing many kinds of learner data, especially that of learner performance. Many training organizations rely on their LMS as a single point of access for all their e-learning content and student records. They are a key enabling technology for "anytime, anywhere" access to learning content and administration. Some systems (LCMSs) combine the above capabilities with authoring and content repository functions. In some LCMSs, you can decouple the authoring tool or content repository components and use them as separate applications without relying on the LMS component of the system. See *4.2 Learning Content Management Systems (LCMSs)* for more details. Authoring tool functionality is covered in a separate ADL paper called "Choosing Authoring Tools" (available at www.ADLNet.gov).

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Other categories of systems that are related to LMSs are covered in *4. Categories and examples of systems to deliver and manage learning.* As described in *1. Purpose and scope of this paper*, it is important to understand the functions these provide in order to be able to precisely address your requirements; an LMS (defined in the sense we define it here) might not actually be what you need.

You need to be careful also about the term "LMS." Industry professionals sometimes use it loosely to describe the other categories of systems described in *4. Categories and examples of systems to deliver and manage learning*. While it is true that the lines between these systems are becoming more and more blurred as these other categories of systems add LMS functionalities and vice versa, it is important to determine and use the most appropriate label for a system according to its primary use and market, in order to avoid confusion. These other categories of systems are designed for different sets of learning functions than a standard LMS.

The following general functions are normally provided by an LMS:

- **Structure** – centralization and organization of all learning-related functions into one system, enabling efficient access to these functions via layered interface navigation functions.
- **Security** – protection from unauthorized access to courses, student records, and administrative functions.
- **Registration** – finding and selecting or assigning courses, curricula, etc. by learners and their supervisors. This may include instructor-led training classes.
- **Delivery** – on-demand delivery of learning content and experiences to learners.
- **Interaction** – learner interaction with the content and communication between learners, instructors, course administrators, as well as between communicative content and the LMS (i.e. SCORM content).
- **Assessment** – administering assessments and the collection, tracking, and storing of assessment data, with further actions taken (possibly in other systems) based on the results of assessment. Many LMSs include the ability to create assessments as well.
- **Tracking** – tracking of learner data including progress on a predefined set of training goals and requirements, and tracking of courses for usage, especially in relation to required deployment of mandated training (for example, compliance training).
- **Reporting** – extraction of information by administrators and stakeholders about learners and courses, including the information that is tracked as described above.
- **Record keeping** – storage and maintenance of data about learners. This includes both demographical info profiling learners and their training progress and accomplishments. This is especially critical when an LMS is deployed as the official "System of Record" for an organization.
- **Facilitating Reuse** – searching and recombining courses and possibly parts of courses for delivery in different curricula and learning tracks (this is a much more prominent feature of LCMSs, but can be included in an LMS).
- **Personalization** – configuration of LMS functions, interfaces, and features by learners and administrators to match personal preferences, organizational needs, etc.
- **Integration –** exchange of data with external systems to facilitate enterprise-wide tracking of learner performance and transfer of user data and to exploit external content and learning resources (i.e. content management systems).
- **Administration** – centralized management all of the functions in this list.

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See *Appendix E. Diagram of Generalized LMS Architecture (including SCORM Elements)* for a diagram of the architecture of a typical LMS.

Added to the above general functions, in the most comprehensive of LMSs (especially ones that incorporate functions of other categories of systems– see *4. Categories and examples of systems to deliver and manage learning)*, one may find tools such as competency management, skills-gap analysis (Gilhooly, 2001), succession planning, certifications, virtual live classes, and resource allocation (venues, rooms, textbooks, and instructors).

Bailey in W. R. Watson & Watson (2007) presents general characteristics of LMSs in education that include:

- Tying instructional objectives to individual lessons
- Incorporating lessons into the standardized curriculum
- Extending courseware several grade levels consistently
- Providing a management system
- Collecting the results of student performance
- Providing lessons based on the individual student's learning progress.

Further functionality is defined by the American Society of Training and Development (ASTD) as:

- Enabling integration with the human resources system
- Incorporating tools to manage registrations, curricula, certifications, budgeting, and scheduling
- Providing access to content delivery
- Enabling content development, including authoring, managing and storing
- Integrating content with third-party courseware
- Assessing learners' competency gaps
- Supporting assessment authoring
- Adhering to standards
- Supporting configuration to function with existing systems and processes
- Providing data security

(W. R. Watson & Watson, 2007). LMSs are typically designed for multiple publishers and content providers and usually do not include their own authoring capabilities (that qualifies a system as an LCMS – see *4.2 Learning Content Management Systems (LCMSs)*. Their main focus instead is on managing content created from a variety of sources (Hall, 2002).

2.2 How widely are LMSs used?

LMSs are utilized within virtually all organizations requiring training or professional development and are the foundation for most corporate e-learning programs (Hall, 2002). They are a major component of most Federal Government training programs and are used extensively throughout the U.S. Department of Defense (DoD). LMSs have also become a staple of the online education provided by learning institutions throughout the spectrum of education from K-12 through higher education. Within higher education and following the pattern of library and enterprise resource planning (ERP) systems (Gallagher, 2007), LMSs are fast becoming a campus utility, expected to be available 24x7 (Camp, DeBlois, & Committee, 2007).

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LMSs are now considered mission critical and have appeared as one of the chief information officers' (CIO) list of top 10 information technology issues in higher education. According to (Camp et al., 2007):

"…findings suggest that overall penetration in higher education has increased by a factor of three since 2000; more than 90 percent of campuses support at least one C/LMS, with nearly 70 percent standardized on a single commercial C/LMS; and although more faculty are using C/LMSs, they are selective and, more often than not, are focused on administrative tools and less on interactive features." (p. 28)

2.3 What are the benefits of using an LMS?

Other than the basic benefits derived from automation and centralization of functions provided by any enterprise system, LMSs have been attributed as having the following benefits:

- Reducing costs through decreased training redundancy and reduced operational errors and down-time
- Maximizing efficiency through the integration of content delivery such as safety issues, operating procedures, maintenance packages, environmental standards, and job reference reducing complexity and costs of auditing
- Leveraging existing resources by including established policies and procedures; utilizing existing training material and links to "off-the-shelf" commercial computer-based courseware (Szabo & Flesher, 2002)

2.4 Types of general learning goals managed by LMSs

In an instructional sense, LMSs are generally designed to account for five basic categories of learning:

- **Initial Learning** – acquiring skills and knowledge for the first time.
- **Continued Learning** – extending skills and knowledge in a particular domain.
- **Remedial learning** – refreshing skills and knowledge for learners whose knowledge has decayed.
- **Upgrade learning** – moving to a higher level of competence in skills and knowledge already acquired.
- **Transfer learning** – transfer of skills and knowledge learned in one particular domain or context and transferring them to a different one. For example, a trained and experienced Flash programmer who is now working in Flex (which uses the same Flash framework but with a different interface).

Most LMSs support all of these goals and although the system functions in an LMS are similar for all five, they are not always the same. For example, the LMS needs to ensure that remedial learning students are not tracked the same way as initial learning students. Remedial learning students should have access to all parts of a course (suspending all forced sequencing), without forcing them to take assessments and be graded as in initial learning.

In a logistical sense, the categories of learning delivery that LMSs can account for are:

- **Learner-led –** asynchronous, on-demand e-learning.
- **Instructor-led –** Live presentation of content and supervision of learning experiences by an instructor.
    - **Co-located –** instructor and students co-located, usually in a classroom setting.

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  - **Virtual –** instructor delivery of learning to students at a distance, using a technology such as video conferencing hardware or web conferencing software. Students may be co-located in a distance learning classroom (without the teacher, who is remotely located). A recording of such a session for asynchronous playback to students then moves into the learner-led category described above.

- **Facilitated –** so-called blended or hybrid learning. It combines elements of learner-led and instructor-led (see above). Facilitated learning is often used in situations where 100% instructor-led training is impractical or costly, and some parts of the content (but not all) can be delivered effectively through e-learning.
- **Embedded –** job and task performance support through just-in-time Help and performance support systems.

Contrary to the instructional goals presented above, LMSs do not often include support for all of these goals; in fact, these are the main differentiators for the categories of systems to manage and deliver learning (see *4. Categories and examples of systems to deliver and manage learning).*

2.5 Who uses LMSs and why?

Some aspects of LMSs can be handled by simply putting files on an intranet file server and using a spreadsheet or simple database for tracking purposes. However, most enterprises' needs go way beyond the capabilities of such a home-grown system. And developing a more robust system in-house can easily turn into a major software system development project, beyond the capabilities and budgets of many organizations. Thus, it is generally most cost-effective to acquire a commercial system, or customize an open source system.

LMSs base much of their value proposition on their optimization for ease of use by administrators and learners, and their automation of time-consuming tasks. They offer streamlined and efficient administrative workflows, which can be very time-consuming without carefully designed tools.

LMSs can be free and open source, but commercial versions are generally cost-prohibitive for small organizations. They also are technically complex and require an administrative and maintenance infrastructure that also can be prohibitive for small organizations. Thus, these systems generally make the most sense for an enterprise with hundreds if not thousands of users, where some level of control and record keeping needs to be exerted over the process of learning.

Generally, an LMS is not needed where:

- There are only a small number of users (in this case, a system may be useful, but it would not be cost-effective).
- Learning can be delivered simply by sending learners a URL to a file located on a file server on the enterprise intranet and they are free to take the module(s) without any performance tracking requirements (or perhaps they can self-report their status).
- Learning is delivered through hard copy medium such as paper documents, CD, or DVD, and no systematic, centralized tracking is required.

LMSs are commonly used by a variety of groups, mainly including content developers, training administrators, course managers, system administrators, instructors, and learners. These roles are often accounted for in the default account categories/permission levels available in many LMS products. Each group uses different functional areas or a particular functional area for different purposes, since each plays a different role in the learning delivery and management process. Figure 1 provides an example of how each group uses various LMS functional areas:

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Functional area	Content Developers	Training Administrators	Course Managers	System Administrators	Instructors	Learners
Learning tracks and curricula	NA	Define learning tracks, curricula, and target groups associated with them	Ensure that course is correctly positioning within learning track or curriculum	Maintain system integrity of learning tracks, curricula, and target groups	Assign learners to learning tracks and curricula per training needs	Choose curriculum or view assigned curriculum
Course delivery preparation	Test developed courses to ensure proper functioning	Review courses in curriculum for content errors	Review individual course for content errors and delivery problems	Import and configure courses	Review courses to prepare for providing instructional support	NA
Course delivery	NA	Monitor to ensure curriculum is delivered as intended in training plan	Monitor to ensure course is delivered correctly	Monitor and allocate course delivery per bandwidth and server constraints	NA	Find, register for, and take courses
Operation of course	NA	Review curriculum to ensure operation as intended	Review course to ensure operation as intended	Configure LMS to enable proper operation of courses	Provide course instructional support (via LMS features that enable contact with instructors)	Use course features as intended
Course progress and completion	NA	Report progress across courses Bill for course usage, if applicable	Report and analyze progress on course Bill for individual course usage, if applicable	Maintain tracking database and generate reports	Monitor learner progress and completion and assign learners to additional courses as necessary	Gauge progress
Assessment	Program assessments (in LMS, if applicable)	Review assessments throughout curriculum to ensure compliance with training plan	Review assessments in course	Configure LMS to enable proper operation of assessments	Review assessment Review assessment results and take appropriate remedial action	Take assess-ment
Learner performance	NA	Assess, document, and analyze performance	Analyze course usage and learner performance to evaluate course effectiveness	Generate statistics and reports per needs of training administrator and course manager	Monitor learner performance and assign learners to additional courses as necessary	Monitor perfor-mance
Competencies	NA	Define competencies	Ensure competencies are integrated into course	Import and export competencies to/from external systems	Take further actions based on learner competencies reported by LMS	Receive competency certifications from LMS

Figure 1: LMS functional areas and roles for each

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2.6 The importance of choosing the right LMS

Choosing a system to manage and deliver your learning is one of the most crucial decisions any training organization can make. Though most of these systems contain the same basic collection of functional elements described in the previous section, they are optimized for different types of learning goals, learners, and organizations. Differences can be major in these respects. If your organization chooses a system that is not optimized for your needs, you could end up wasting your organization's money and wasting time for your learners and administrators, or worse, predisposing learners against learning opportunities that may be important but are difficult to access and take.

Another critical factor in choosing these systems is durability. This relates to whether the system will have longevity in the marketplace such that it continues to be available and supported with periodic maintenance and upgrades. This is important, at least to account for evolutionary changes in the IT environment (both hardware and software) within which it operates. It also relates to whether the system will, in the future, support delivery of new file formats, possibly incorporating revisions to standards like SCORM.

As with all enterprise systems (which LMSs are), they should also be chosen with consideration for extensibility, scalability, and, generally, how they will fit and integrate within the overall enterprise architecture of the organization. Extensibility considerations tend to take into account the modularity of the system and how services can be customized or increased to meet changing user needs. When thinking about scalability, the growth patterns and projections of the organization are important in evaluating whether or not an LMS can meet the potential volume demands through growth. Fit tends to consider the organization's other non-learning specific business needs and how the LMS will integrate and support other business-related systems. To this end, it is very important to involve IT department staff in all discussions from the very beginning.

3. Process for choosing an LMS

ADL recommends the following high-level process for choosing an LMS.

1. Hold meetings among stakeholders and create documents that outline the basic feasibility of an LMS acquisition, and the how your organizational goals can be met with it. You need to answer such questions as: What business problems do you hope to solve with it? What are the risks? What resources will it require? What new processes and business rules will it require? All of this needs to be looked at under the lens of feasibility. For instance, if new processes and business rules are required, who will create and enforce them? If you are going towards a competency-based HR environment, who will create and maintain the competency data, and who will verify mastery of competencies?

2. With stakeholders, decide on a process and schedule (preferably with a formal project plan) for how the LMS acquisition project will proceed, using the high-level steps outlined here, or some other process.

3. Determine the **high-level requirements** for your LMS, in each LMS functional area described in *2.1 What is an LMS?* Ensure that you get input from all groups of potential users, not just stakeholders, and solicit input from your HR and IT departments. It is important to stick to only the critical, high-level, and highly differentiating requirements at this point. That will serve to quickly filter many unsuitable candidates when you get to step 6 below. This may require a formal requirements definition effort, especially if you are a large enterprise with many different groups of potential users who may have different (and hard to predict) needs from your organization.

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If you have never used an LMS before, you may want to consider gaining a year of experience with a simple, inexpensive or homegrown system before you buy a major enterprise system. This could help clarify your goals and requirements substantially.

Some important general considerations that may impact your list of high-level requirements at this point include:

- Whether you will need support for compliance training. This will require robust tracking features and probably certain kinds of reports.
- Whether you need to deliver COTS content, as opposed to content you develop yourself. In the former case, you will need to ensure that the COTS content will run successfully in the LMS.
- Whether you will need your LMS to focus broadly on HR and HRD (Human Resource Development) issues rather than strictly on traditional training.
- Whether you want an "all in one" system that contains everything you need, or whether you already have some LMS software functions or components in place that you do not need included in the LMS. Even if you do not have these functions already, you may be planning to accumulate them gradually outside of the LMS you purchase.

4. Determine your **budget** for purchasing the system and associated support/training contracts, as well as any customization you need that you predict that the system will not provide out of the box. To provide a rough idea of cost, systems range from $14,997 – $1.6M for a hosted LMS solution for 25,000 users with a 3-year cumulative license; the mean price for such a system is $493K, and the median price is $323K (Brandon-Hall, 2011). (See *5.2 Pricing models* for more information about pricing.)
5. Determine the **category of system** you will need (see *4: Categories and examples of systems to deliver and manage learning*) and types of learning you need to deliver (see *2.4 Types of learning managed by LMSs).* If there are only certain major capabilities that you really need, you may be able to save money by buying only the components or services you need. If you already have a CrMS, for instance, you want to consider acquiring or developing just the course delivery module, or vice versa, instead of an entire LMS.
6. Identify **specific systems** that match the category and support the types of learning you identified in step 5. Because these categories overlap, you may identify more than one category for consideration. You may decide at this point to develop your own product rather than purchase a COTS LMS. Note that if you are a U.S. government entity, the government acquisition process requires justifications for acquisition choices. You will need to validate or justify your decision to develop your own system (vs buy a COTS product).
7. Develop and populate a system requirements **matrix** that allows assessing the systems identified in step 6 against your requirements developed in step 3. See the *Appendix A: Sample System Requirements Matrix* for a sample. If you are considering more than one category of system, you may want to complete a separate matrix for each different category of system you have identified as a requirement for your organization, since each category of system has its own distinct parameters and typical feature sets. After completing the separate matrices, you will then need to decide which category you will pursue, if you are intent on or limited to purchasing only one system.
8. Filter the list of **potential candidates**, eliminating those that do not meet your minimum requirements and/or are over your budget. It is important to focus on your core needs - use weighting in the provided selection matrix (see *Appendix A: Sample System Requirements*

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Matrix) to establish the absolute vs "nice to have" requirements. Create and send requests for information (RFIs) or requests for proposals (RFPs), or other formal documentation to these candidates at this point, if that is required for your acquisition process. Templates for these documents are usually prescribed within corporate or government organizations. If not, you can find templates on learning technology consulting firm web sites (for example, Brandon Hall at http://www.brandon-hall.com/publications/howtorfp/howtorfp.shtml), LMS vendor web sites, or by searching on the Web.

9. Compile a detailed, **comprehensive features list** for all of the remaining candidate systems. You may want to start this list by sampling the features of one system that seems to be the most feature-rich, and add any features uncovered by your analysis of other systems as you complete the comparison process. Or, you can use part or all of the criteria mentioned in *6. Criteria for assessing quality and suitability of LMSs* as your features list. You may want to edit this list of features to only those that you care about now; however, this may be limiting since you may be unfamiliar with the usefulness of some features or they may become useful in the future.

10. Develop a system features rating matrix (see the *Appendix B: Sample System Features Rating Matrix* for a sample) that **compares the systems** identified in step 8 using the features list developed in step 9. Complete as much of this matrix as possible from the systems' documentation; if you need more information, ask their sales representatives for it (though beware of overblown claims—verify lofty ones independently if possible). Assign a numerical rating for each cell in the matrix, indicating degree of implementation of that feature; "0" would indicate that a particular LMS does not have that feature, and "10" indicates that it has a very robust implementation of the feature. The matrix should weight each feature according to its importance to you, enabling a rollup score for each system.

11. Contact the **top scoring vendors** (three to five is a reasonable number) from the previous step and ask for a presentation/demo. Ask the vendor for a demonstration in your facility, running your content on their system. The vendor may want to present a canned demo of their product using PowerPoint or Flash, and that is fine as a general overview of the system's capabilities, but you should see how well the system expresses these capabilities within your IT environment using real content. You might also want to ask vendors to provide a list of three customers who would be willing to host site visits or talk to you WITHOUT the vendor present. Some experiences you might want to ask these customers about are:

    - Contract negotiations
    - Customizations and turning on/off baseline features
    - Implementation process
    - Responsiveness and quality of support

    It is recommended that you consider creating use case scripts (scenarios that will demonstrate the system's ability to meet your specific needs), representing common, mission-critical tasks that an LMS user would perform. During their demonstration, the vendor performs the steps required to fulfill each use case. This is a good way to evaluate how effectively and smoothly the system maps into your use cases. You can also request that the vendor set up a sandbox for hands-on testing with the system by your administrators, instructors, and learners. LMS acquisitions are usually expensive, so it is not unreasonable to ask for this.

    It is important to establish a firm, contractually-binding baseline of what you would be buying "out of the box" vs what would require customization above and beyond that baseline. Some vendors may blithely tell you that their system can meet certain requirements of yours, but what it

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really means is that the system has an architecture that allows integration of those features with some amount of customization, which is an additional charge. You should clarify with the vendor what constitutes "customization" (ie, requires actual programming) vs "configuration" (ie, changes that can be made by the system administrator without any programming and system integration).

12. **Augment the matrix** with the additional information gained from step 11, adding any impressions and notes from the vendor demos.
13. Make your **decision based on feature comparison** (including the weighting you have assigned for each feature) and experiences from the demo sessions, taking into account TCO (total cost of ownership), including the application, training, "software assurance" (yearly cost that includes upgrades, version releases, etc.), maintenance, hardware that you will need to run it on, etc.), customer support, and any intangibles. Total Cost of Ownership (TCO) is usually a 5-7 year window for LMSs. As enterprise systems usually require a minimum server architecture and LAN support, another consideration is whether a hosted solution (see *5.7 Hosted solutions*) or component-based architecture solution (see *7.11 Component-based architecture*) may be right for you, if one is available from the vendor. Get someone (who may not be in your learning organization) who has negotiation skills and experience involved to negotiate such important terms as pricing and licensing.

Other processes for selecting LMS or other large systems that rely more heavily on demonstrations of use cases are possible, for example, Brandon Hall's method for selecting an LMS (Brandon Hall Research, 2011, and Brandon Hall Group, 2012).

After making your decision, be clear in internal communications what the system can and cannot do. In other words, "promise low, deliver high". Make it clear to all of those who will use the system in your organization what new roles and responsibilities they will have to take on due to implementing the system, and get their buy-in early on. It is unrealistic and unfair for them to expect that system administrators will do everything for them. As users of the system, they should experience tangible benefits (if they don't, you need to reevaluate your requirements). They should understand that "to get, they have to give".

4. Categories and examples of systems to deliver and manage learning

Systems to deliver and manage learning run a wide gamut. This section describes the major categories of available systems. These categories are key to choosing a system, since they set the stage for allowing you to align your major requirements to the type of system you need. It is important to note that these categories are not mutually exclusive. Some systems have core elements that qualify them for two or more categories. However, in these lists, systems are assigned to one category as their primary intended use or design architecture.

As described earlier, the labels for categories are used loosely by vendors and others. Many vendors simply categorize their system based on where they perceive the bigger market lies for their collection of capabilities, not based on their system's primary functionality. The other factor that plays into the categorization and labeling of systems is user community usage patterns. Many users in the higher education community will call whatever system they use a course management system (CrMS), whether it strictly fits that definition or not.

Although all categories of systems to deliver and manage learning are discussed in this section, this paper focuses mainly on systems that can be categorized as LMSs.

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The subsections in this section describe the categories of systems and list examples. Web sites for product examples are provided in case further details on each system are needed. Note that some systems appear in more than one category, pursuant to the explanation above, as they fulfill multiple purposes.

Note: the lists of examples are not comprehensive, nor do they represent an endorsement of particular products.

4.1 Learning Management Systems (LMSs)

LMS are optimized for delivery of learner-led and embedded learning, explained in *2.4 Types of learning managed by an LMS.* They can include support for facilitated and instructor-led training and education, but that is usually not their primary focus. They are primarily designed to manage and deliver asynchronous e-learning, although many of the large LMSs for corporate use offer tools for administering traditional classroom-based, instructor-led training events (this is the primary function of CrMSs described in *4.3 Course Management Systems (CrMSs).*

LMSs are used primarily in the business and government training community. This is ingrained into the minds of users to the point where many systems that technically fit into one of the other categories are often termed an LMS by training community users. Thus, the LMS label is used loosely, but for purposes of differentiating and categorizing systems in this paper, "LMS" includes only the systems that are primarily designed to manage and deliver asynchronous e-learning, as described above.

Examples are:

- Atlas Pro [Government off-the-shelf (GOTS) product – see *5.4 Government off-the-shelf (GOTS) solutions* for more information]
  https://learn.dau.mil/html/login/publicSite/WhatIsAtlas.jsp
- ABC Academy®
  www.danishprobe.com
- CERTPOINT VLS®
  http://www.certpointsystems.com/
- Chamilo [open source]
  http://www.chamilo.org/en
- CLIX®
  www.im-c.com
- ComplianceWire®
  www.kaplaneduneering.com
- CompanyCollege LMS®
  www.bizlibrary.com
- Cornerstone OnDemand Talent Management Suite®
  http://www.cornerstoneondemand.com
- CourseAvenue Deliver®
  http://www.courseavenue.com/
- Docebo [open source]
  http://www.docebo.org/doceboCms
- Dokeos [open source]
  http://www.dokeos.com

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- Learning Environment®
  http://www.desire2learn.com/learningsuite/corporate/
- eFront [open source]
  http://www.efrontlearning.net
- Google CloudCourse®
  http://google-opensource.blogspot.com/2010/05/cloudcourse-enterprise-application-in.html
- GreenLight Learning Management System®
  www.silkroad.com
- ILIAS [open source]
  http://www.ilias.de
- JoomlaLMS® [open source]
  www.JoomlaLMS.com
- KnowledgeHub®
  http://www.elementk.com
- KMx Enterprise®
  http://www.kmsi.us/kmx_product_information.htm
- Krawler LMS®
  http://www.krawlerlms.com
- Learning Studio®
  http://www.pearsonlearningsolutions.com/pearson-learning-studio/
- Meridian Global LMS®
  http://www.meridianksi.com
- Moodle [open source]
  http://moodle.com/
- Mzinga Social Learning Suite®
  http://www.mzinga.com
- OpenClass® [free, hosted solution]
  http://www.pearsonlearningsolutions.com/pearson-learning-studio/
- Openelms™
  http://www.openelms.org/
- Oracle Learning Management®
  http://www.oracle.com
- OutStart TrainingEdge.com®
  http://www.outstart.com
- PeopleSoft Enterprise Learning Management (ELM)®
  http://www.oracle.com/applications/
- Plateau Talent Management Suite®
  http://www.plateau.com
- Saba Enterprise Suite®
  http://www.saba.com

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- SAP Enterprise Learning®
  http://www.sap.com
- SCORM Cloud®
  http://www.scorm.com/scorm-solved/scorm-cloud/scorm-test-track-scorm-cloud/
- SumTotal® TotalLMS®
  http://www.sumtotalsystems.com
- TEDS Learning on Demand®
  http://www.teds.com/index.php/solutions/learning-management
- Taleo Learn®
  http://www.taleo.com/solutions/learning
- TM SIGAL®
  http://www.technomedia.com
- Training Jungle®
  www.redtray.co.uk
- Training Partner®
  http://www.trainingpartner.com/LMS.aspx
- UdutuTeach/Learn®
  http://udutu.com/products-udututeach-and-udutulearn.html
- Veloce®
  www.syslps.com
- ViewCentral®
  http://www.viewcentral.com
- UpsideLMS®
  http://www.upsidelearning.com
- XStream RapidShare LMS®
  http://www.xstreamsoftware.com

4.2 Learning Content Management Systems (LCMSs)

LCMSs are closely related to LMSs, providing much of the same functionality with the addition of content authoring. The focus of an LCMS is the instructional content—its creation, reuse, management, and delivery. This contrasts with the logistics of managing learners, managing learning activities, and competency mapping provided by an LMS (Oakes, 2002). In other words, an LCMS focuses on the creation of learning objects (LO) while an LMS manages the learning process as a whole, incorporating the LCMS within it (W. R. Watson & Watson, 2007). Hall (2007) states that 74% of LCMSs in their LCMS research report include LMS functionality. Both systems, however, manage and deliver instructional content usually in the form of LOs, with an LMS being the more systemic of the two.

As in the case of LMSs, LCMSs are optimized for delivery of learner-led and embedded learning strategies, explained in 2.4 *Types of general learning goals managed by LMSs.* Like LMSs, they can include support for facilitated and instructor-led training and education, but that is usually not their primary focus. In the simplest form, an LCMS is an LMS integrated with authoring tool and content repository functions. Content repositories are usually designed to manage many different types of content objects, not just e-learning (or even training-related), and generally include the following features (that are not usually found in an LMS):

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- Versioning of files and/or content objects
- Ability to manage diverse and complex content object types. This includes providing navigation controls, look and feel, and a table of contents for a wide range of content object types.
- Web interface directly to the content files in the LCMS's repository
- User roles and privileges to manipulate content
- Cataloguing (through metadata tagging) and search to enable discovery of content objects and/or files

Like LMSs, LCMSs are used primarily in the business and government training community. Note that the term LCMS is sometimes used to refer to an LMS that has bolted on authoring capability (without meeting the spirit of the functionality described here for a true LCMS).

The primary advantage of LCMSs over LMSs is that LCMSs enable assembly of courses (often dynamically) from a variety of smaller source content objects. Thus, if your environment requires output of a variety of materials from a variety of sources (for example, producing e-learning from instructor-led training manuals and vice versa), this is probably a good choice of a system.

Be careful if you already have established an e-learning development capability, and staff in your organization are already using preferred standalone authoring tools. There may be significant resistance to changing authoring tools midstream (such as to an LCMS). In many cases, however, they can continue to use their preferred tools, and files produced by these tools can be input into the LCMS.

LCMSs have the following additional advantages over LMSs:

- They include an integrated authoring tool, which usually allows you to import and edit existing content with export to multiple formats conformant to multiple standards or standards versions.
- Individual assets and learning objects (including screens) can be managed, not just courses.
- Assets can be version controlled.
- They are better optimized for delivering performance support modules, because of their object-based architecture (i.e., learning objects can be reassembled dynamically in a format that is better suited to the needs of users looking for just-in-time information).
- Master copies of content objects ripple changes through all outputs.
- Competencies and objectives can be mapped explicitly to any level of course organization and to learner progress, in some cases assembling individual courses (not just curricula) for students dynamically based on their training needs.
- Course units and assets can be easily reused (within the system).

LCMSs have the following disadvantages compared to LMSs:

- The student management functions tend to be less robust, since the system concentrates more on the authoring, assembly, and delivery of content.
- Their capabilities are usually predicated on doing everything within the LCMS system. They may not interoperate well with other systems (for example, an external authoring tool).
- Navigation controls for courses usually are provided by the LCMS, not the content (this is especially true where the content is assembled dynamically).
- The concept of an LCMS may be very attractive, but implementation requires more of a commitment (than an LMS) to reengineering your organizational culture to leverage its reusable

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learning object paradigm. If you do not make use of this LCMS capability, you could end up wasting money (over the cost of a comparable LMS).

Examples are:

- ATutor [open source]
  http://www.atutor.ca/atutor/index.php
- Claro®
  http://www.dominknow.com/products/lcms.cfm
- Docebo [open source]
  http://www.docebo.org/doceboCms
- GreenLight Learning Content Management System®
  http://www.silkroad.com
- eXact LCMS®
  http://www.exact-learning.com/en/products/learn-exact-suite/exact-lcms-learning-content-management-system
- OutStart LCMS®
  www.outstart.com
- Saba Content Management®
  http://www.saba.com
- SAP Enterprise Learning®
  www.sap.com
- SumTotal LCMS®
  http://www.sumtotalsystems.com/products/learning-content-management-system.html

4.3 Course Management Systems (CrMSs)

CrMSs are most commonly used in higher education rather than enterprise training environments. They are sometimes called Education Learning Management Systems (ELMSs). The primary focus of CrMSs is to manage all aspects of **live** instructor-led classroom training, according to the categories of learning delivery explained in *2.4 Types of general learning goals managed by LMSs.* They may include the ability to deliver learner-led courses, but these are usually supplementary or ancillary to the instructor-led courses they manage. As described earlier, many LMSs incorporate some level of CrMS functionality and vice versa, since many enterprises want to manage their instructor-led learning and e-learning in one system.

Do not confuse *course management system* (CrMS) with *content management system* (CMS). The acronyms are differentiated here so as not to confuse, but often the same acronym is used (CMS). CMSs are designed to manage work flow needed to collaboratively create, edit, review, index, search, publish and archive many kinds of content, mostly related to document publication.

CrMSs are used primarily in the academic community. That is their primary market target. CrMSs are sometimes labeled as LMSs within the user community, but they are distinctly different in the sense that they do not deliver the core learning experiences—those are provided live in classrooms. However, a CrMS vendor that has added e-learning delivery capability may term themselves an LMS (though the preponderance of their functionality really qualifies them as a CrMS).

The core features of a CrMS are:

- Instructors can post information and materials on the web relating to their classes.

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- Instructors and administrators can manage and schedule a variety of class-related resources, including classrooms and instructors, and ancillary instructional materials such as references and required readings. Conflict handling is often a part of these systems.
- Instructors can organize a class into groups and provide a group work space for working on group-specific tasks and projects.
- Instructors can mark and evaluate learner work while online.
- Instructors have grade book functions for recording learner performance.
- A portfolio space can be created for learners where they can showcase their work in a course, display contact information and a photo.
- Instructors can integrate appropriate support materials including exercises, reference materials, labs, tests, etc. by course, class section, curriculum, etc.
- Users can collaborate (at least among learners in the same class) using threaded discussion, chat and other communication or social media tools.

In some cases, the decision whether to acquire an LMS vs LCMS may be difficult, as there is significant overlap. However, CrMSs are different from both of these in the sense that they generally do not provide the capability to deliver the core learning; they are mainly designed to manage the supporting infrastructure for live instructor-led classroom training. Thus, it is irrelevant to discuss advantages and disadvantages of CrMSs over LMSs, since they are designed more for education than for training.

Keep in mind that because of the overlap in functions and features, differing product marketing strategies, and lack of universally accepted labels, the products in this list are often considered as LMSs.

Examples are:

- .LRN [open source]
  http://dotlrn.org/
- Adrenna Academic [open source]
  http://www.adrenna.com/open-source-lms#adrenna_academic
- Blackboard®
  http://www.blackboard.com
- Claroline [open source]
  http://www.claroline.net/
- CloudCourse [open source]
  http://code.google.com/p/cloudcourse/
- CourseCompass®
  http://www.pearsonlearningsolutions.com/career-schools/lms-cms.php
- Edvance360®
  https://www.edvance360.com/
- GoToTraining®
  http://www.citrix.com/English/ps2/products/product.asp?contentID=1862273&ntref=prod_top
- Learning Studio®
  http://www.pearsonlearningsolutions.com/pearson-learning-studio/
- LON-CAPA [open source]
  http://www.lon-capa.org/

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- Moodle [open source]
  http://moodle.com/
- OLAT [open source]
  http://www.olat.org/website/en/html/index.html
- Sakai [open source]
  http://sakaiproject.org/portal
- WebStudy®
  http://www.webstudy.com

4.4 Virtual Learning Environments (VLEs)

There are many software tools designed for general web-based virtual business meetings and collaboration. VLEs (sometimes called Virtual Classrooms) are a subset of these. The primary focus of VLEs is to deliver, and to some degree, manage **virtual** instructor-led learning (either synchronous or asynchronous). VLEs support management of learning to varying degrees, and to this extent they resemble CrMSs, but they focus mainly on providing the delivery capability. They can include support for asynchronous learner-led e-learning, but that is not their primary focus. VLEs are generally more targeted towards the formal educational environment rather than corporate training.

As in the case of CrMSs, it is moot to discuss advantages and disadvantages of VLEs as compared to LMSs, since they are designed for a different kind of learning experience. However, because they overlap much more nowadays with LMSs in terms of sharing the ability to deliver e-learning, it is worth pointing out some of the differences in the way these two systems function.

VLEs have the following fundamental differences from an LMS:

- They support the collaboration needs of virtual courses, thus emphasizing collaboration much more.
- They are learning event-driven instead of course-driven.
- Assessments are usually tracked as separate activities, not as part of a specific unit of the course.
- Student performance is tracked using instructor grade book data, for instance, narrative summaries of student accomplishments and needs, test scores, and assignments completed.

Many VLEs incorporate videoconferencing capabilities, used typically to allow the instructor to broadcast a “talking head” of him/herself to students while slides or other media is displayed. See *7.13 Video conferencing integration* for more information.

If you are considering acquiring a VLE, do not underestimate the retraining it may take for your classroom instructors to become effective VLE instructors. VLEs have different instructional constraints and opportunities, and potentially many more technical distractions than a live classroom.

Examples of VLEs are:

- Acrobat Connect®
  http://www.adobe.com/products/acrobatconnect/
- Collaborate®
  http://www.blackboard.com/Platforms/Collaborate/Products/Blackboard-Collaborate/Web-Conferencing.aspx
- Centra®
  http://www.saba.com

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- Connect®
  http://www.adobe.com/products/acrobatconnectpro/
- LiveRoom®
  http://www.desire2learn.com
- Social Learning Suite®
  http://www.mzinga.com/a/pdf/MzingaDS-HRSolutions.pdf
- WebEx Training Center®
  http://www.webex.com

5. Special features and issues to consider

5.1 LMS skins and templates

LMS skins are generally style sheets that globally control the appearance and format of the LMS interface (differentiated from skins used in the context of authoring tools, which refers to the ability to globally apply a look and feel to the content itself). They usually include banner graphics, logos, color schemes, etc.

Skins can enable local variations on parent LMS interfaces, providing each organization within the enterprise with its organizational branding. This can ease the barrier of sharing an LMS across an enterprise, potentially saving a lot of money. Skins can be determined in advance, or can be dynamically applied depending on the user's demographic information (such as organization they belong to, or the country in which they reside) in their profile. Skins can include changing the language of the interface.

The concept of templates (some other term may be used for this concept in the product) refers to any saved set of parameters that can be applied to any content or functional object. These parameters can govern such things as workflows, course configuration, and learning tracks.

Templates in the context of LMSs usually refer to sets of permissions or roles that are repeatedly assigned to individuals who are members of certain groups or functioning in certain roles, or whole groups. Thus, a whole set of permissions can be applied all at once, to more than one user. Templates can also refer to screen templates for building assessments that can be created and used within an LMS.

5.2 Pricing models

As with many complex, large software systems, vendors will have their own particular pricing model that they feel positions them best in the marketplace and suits their needs; this makes it difficult to compare prices between vendors. However, there are certain basic categories of pricing models, as follows:

- **Seat-based** – this model uses the number of employees in the enterprise, or possibly the number of employees who will ever need training in the enterprise as a basis for pricing. These "seats" are a maximum number of people who may end up logging in to the system over its life cycle. There are usually tiers of seats (for example, up to 10,000 vs up to 20,000 users). Do not confuse seats as a pricing model with system capacity seats. The latter is the number of concurrent users that can safely use the system without overburdening it.

  Seat-based pricing can run into problems with "extranet" users. If partners, customers, and others outside of the enterprise (i.e., other than employees) need to use the system, accounting for their numbers may be complicated, and may need to be based on unreliable estimates.

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- **Usage-based** – this model is based on the number of students who actually register for classes. It is not based on the potential number of users who could use the system, as in seat-based pricing, but the number who actually do use it or indicate that they intend to use it. The time period needs to be accounted for in the price as well; 1000 users registering for a course and only using it for one day can be a different pricing scenario than those 1000 users using that course for 6 months.

  This model is particularly attractive in the case of anticipated LMS usage surges, due to such events as new product releases and seasonal cycles. In these cases, where there may be little usage of the system except in certain short periods, paying for a baseline of seats may be less economical than paying per use, for time used.

  Usage-based models can make a hosted solution (see 5.7 *Hosted Solutions*) especially attractive, since your organization does not need to permanently maintain a full complement of server, bandwidth, and support resources to handle the highest load times. That is the responsibility of the vendor, and you will only be charged for the (potentially) short time that usage peaks.

- **Storage-based** – this model is based on the size of the files that are stored in the content repository section of the LMS; 10 Gb of files will cost more than 5 Gb of files, no matter what the usage patterns of either.

5.3 Open-source or freeware solutions

Open source options are attractive due to the absence of any licensing cost. However, it is important to be aware of the pros and cons of acquiring an open source solution, as the cost could, over the life of the system, equal or exceed a commercial system. It's easy to be over-enamored of the free license aspect and ignore the required (possibly extensive) customization and support that may be necessary.

It is also easy to overlook the potential advantage of open source systems in that the product can be completely tailored to the particular requirements of the organization. If managed properly, this advantage can make an open source solution cheaper, not just because the license is free, but because the development and customization efforts can be focused solely on the needs o the organization and nothing more. Contrast this with a commercial product with lots of features that your organization may not need (but you are paying for them nonetheless). The business model for a standard commercial system is to build to the widest set of possible requirements to attract the widest client base. Your organization may not have all or even most of these requirements.

All of the above being said, acquiring an open source LMS usually does save money. For instance, the manager of a large U.S. government agency's e-learning initiative reported to the authors that switching to an open source enterprise LMS is costing them only 60% of the ongoing costs of the commercial system they had been using.

Open source systems are indicated in the lists of systems in *4: Categories and examples of systems to deliver and manage learning.* Descriptions of popular open source systems can be found at http://barrysampson.com/2009/04/open-source-lms-10-alternatives-to-moodle/

On October 16, 2009, U.S. DoD issued new guidance on open source software (see http://powdermonkey.blogs.com/files/2009oss.pdf). The guidance establishes open source software as having equal weight as proprietary software during acquisition evaluations. It is a break from the past, when open source software was deprecated for use in DoD due to security and quality concerns. The benefits of open source software are described in this guidance document as follows (open source is referred to as OSS):

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- The continuous and broad peer-review enabled by publicly available source code supports software reliability and security efforts through the identification and elimination of defects that might otherwise go unrecognized by a more limited core development team.
- The unrestricted ability to modify software source code enables the Department to respond more rapidly to changing situations, missions, and future threats.
- Reliance on a particular software developer or vendor due to proprietary restrictions may be reduced by the use of OSS, which can be operated and maintained by multiple vendors, thus reducing barriers to entry and exit.
- Since OSS typically does not have a per-seat licensing cost, it can provide a cost advantage in situations where many copies of the software may be required, and can mitigate risk of cost growth due to licensing in situations where the total number of users may not be known in advance.
- Open source licenses do not restrict who can use the software or the fields of endeavor in which the software can be used. Therefore, OSS provides a net-centric licensing model that enables rapid provisioning of both known and unanticipated users.
- By sharing the responsibility for maintenance of OSS with other users, the Department can benefit by reducing the total cost of ownership for software particularly compared with software for which the Department has sole responsibility for maintenance (e.g., GOTS).
- OSS is particularly suitable for rapid prototyping and experimentation, where the ability to "test drive" the software with minimal costs and administrative delays can be important.

(Memorandum Clarifying Guidance Regarding Open Source Software (OSS, Oct. 16, 2009)

What is important to understand about open source software is the relationship it behooves you to build with the open source community that has arisen for the open source product you are acquiring. Staying in touch with the community in order to be able to discover and use already developed modules of functionality that you need (that are not part of the product baseline) can decrease your customization costs enormously. Open source communities often remind you that deploying open source means you are a responsible member of their community. There is an expectation that you must contribute, as well as receive code, training, and documentation from the community. The cost of staying active in the community and both researching and acquiring as well as sharing your products and solutions must be factored into the level of effort for acquiring an open source tool.

It is also important to evaluate the strength and size of the open source community for the open source product you are acquiring, as well as the longevity of the product. This can mitigate obvious concerns that major sponsors of open source software can stop development at any time, or that communities can atrophy. Another possible concern is that a tool can grow so quickly in its popularity that documentation takes a back seat to development and has not caught up to the current release of the software; especially in the case of open source software, where you have no vendor who is obligated to support you, a lack of adequate documentation can make a product difficult to install, use, maintain, and troubleshoot.

Finally, the baseline versions of some open source products are very basic; some level of customization is often needed to make the software not only meet your special requirements but also meet a modest level of universally recognized functionality for the type of product. It may be risky to assume that an open source product will be usable straight out of the box. If you have no development resources ready and willing to augment the product's functionality right after you acquire it, you may not be able to use it for some time.

Due to the above concerns, despite their economic advantages and often robust functionality, open source systems have not yet taken up a substantial share of the LMS market. According to a 2011 study across

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corporate and government enterprise learning audiences (DiDonato, 2011a), 12% of LMS implementations are open source systems.

Freeware may or may not also be open source. Freeware may have restrictions on copying, distributing, and making derivative works of it, where open source software does not. And freeware does not necessarily make source code available. Freeware may be restricted to personal use, non-profit use, non-commercial use, etc. Freeware that is not open source is a risky investment, since you cannot easily customize it.

There may be special restrictions on use of freeware within your organization. For U.S. DoD, see http://www.acq.osd.mil/ie/bei/pm/ref-library/dodd/d85001p.pdf

See The Complete(?) list of Open Source Learning Management Systems (Gilfus Education Group) at http://www.gilfuseducationgroup.com/open-source-learning-management-systems-the-complete-list?goback=%2Egmp_2386016%2Egde_2386016_member_132664397 for a list of open source LMSs primarily for use in higher education and K12 learning.

5.4 Government off-the-shelf (GOTS) solutions

This section only applies to government entities. GOTS software can be created either by the technical staff of a government agency or by a commercial vendor (usually the latter). GOTS systems usually have the following characteristics:

- The government has direct control over most aspects of the product, including the source code.
- The vendor or creator has given a license to the government entity who paid for it to freely use and share it within the government. The license does not permit the government to give or sell it to outside entities. In most cases, however, the software can be sold by the vendor to an outside entity.

Many of the same considerations described in *5.3 Open-source or freeware solutions* apply to GOTS solutions as well.

A popular model for GOTS installations is to have regular meetings where representatives from organizations that use the system throughout government discuss new requirements and possible new features. At these meetings, agreements are made between the representatives as to sharing the cost for adding these features (which, after they are developed, are available to all users).

The original vendor/developer is usually the preferred entity for doing the customizations, since their developers were directly involved in creating it and have the most knowledge about working with the code base. This pre-existing experience and expertise can substantially reduce the cost of further development and customization. A GOTS license does not stipulate that the original vendor has to do the customization, however.

5.5 Offline player capability

Offline players allow content to be played in environment where is no or limited bandwidth or connectivity to the LMS. An offline player is necessary for communicative content only (i.e., to store student performance data); otherwise, the content could simply run in a browser as any web-based application. In these cases, the learner gets the content from a CD or from a download at a time and place where bandwidth and connectivity is available. He or she runs the course(s) on their local system, which could be their own computer or a community shared computer. Then, he or she uploads performance data to the LMS at a later time from a different computer which has sufficient bandwidth/connectivity.

Sometimes offline players are needed when there is a diversity of content, and all of it cannot be delivered through the LMS due to file format incompatibilities between the content and the LMS. In this case, the

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LMS can be used to author and deliver assessments and store tracking data only. The delivery capability can be handled through an offline player (probably provided by another vendor) that can display the content. Learners can take courses using the offline player and then log in to the LMS to take the assessment and have their performance tracked.

There are two flavors of offline player capabilities, representing two learner scenarios.

- If you have intermittent connectivity (for example, Navy personnel on ships who have connectivity at their base but not on their ship), you would do something like the following:
    1. Log in to the LMS.
    2. Check out required/desired course(s). This locks the course(s) down so you can only take them in offline mode (otherwise there could be data conflicts with taking the same course in both online and offline mode).
    3. Take the course in offline mode through your offline player.
    4. When you return to a location that has connectivity, you log in to the LMS and check the course(s) back in.
    5. The offline player updates all of your records in the LMS to reflect offline courses taken, test scores, etc.
- If you have no connectivity (for example, you don't have your own computer and/or are in a remote area with no internet connection), you would do something like the following:
    1. Someone in your organization (for example, an administrator at your HQ site) connects to the LMS.
    2. He or she checks out a student database for a selected group of students, along with the catalog of courses needed for those students. This database contains all of the records of student performance, etc. He or she downloads this as a .zip file and puts it on a USB drive.
    3. This drive is sent to the learner location.
    4. At the learner location, the USB drive is loaded on a community computer(s) that everyone shares, or individuals' computers.
    5. Each person takes their required or desired course(s) using the offline player. As courses are taken, data is written to the student database about student performance, courses completed, etc.
    6. After everyone has taken their courses, a .zip file is created from the student database on the USB drive, using a utility. If individual students have taken courses on their personal computers, the files need to be collected onto one computer, and this utility consolidates them into a single .zip file.
    7. This .zip file is sent back to the site that has connectivity.
    8. An administrator at this site uploads the student database to the LMS using a web service.

5.6 Security considerations for LMSs

Like any other enterprise system, LMSs must meet the security needs of the organization. This is especially true in the current era, where LMS functionality is largely delivered via the Internet, not enterprise intranets or extranets (the driver for this migration is mostly to allow greater access to learning).

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For commercial installations, LMS security amounts to:

- Protecting against unauthorized login. This is primarily not so much a function of the LMS, whose login functionality relies on universal web standards, but rather the placement of the system within the corporate intranet environment and the inherent security features of that placement. Commercial entities are of course concerned about other organizations gaining competitive advantage by seeing the training of competing companies, and government has obvious security concerns, so access to the system is a primary concern.
- Locking users out of capabilities that are not included in their user profile, in other words, keeping users from doing particular things once in the system that they are not authorized to do. All LMSs include levels of permission based on roles, but beyond this, they vary widely in terms of the types and number of roles and permissions that can be assigned.
- Segmenting system permissions so that they map to the levels and specific kinds of permission that your organization requires. The question here is, if the system forces you to use a permission/roles assignment template, how applicable is it to your environment, and can templates be tailored to meet your needs? Is there an override that permits assignment of individual permissions on a function-by-function basis?

For DoD organizations, there are specific considerations relating to the possible harmful effects to national security and individuals' life and limb due to unauthorized access to the system and particular courses that may be classified, etc. There are a number of issues that need to be considered in this regard. See the *Appendix F: Security Considerations for DoD LMSs* for a detailed list.

Privacy policies may be an issue depending on how public access to your LMS is and what kind of information you store on it about your users. EU Internet privacy rules, Canada's Freedom of Information and Protection of Privacy Act, and the US Patriot Act may be a consideration.

It is important to find out what programming language and third party OEM components were used to build the LMSs you are considering acquiring. There are innate security considerations for some programming languages, like PHP.

5.7 Hosted solutions

Most LMS vendors offer a hosted option for their LMS. A hosted LMS is installed and managed on the vendor's server by their staff, rather than behind your enterprise firewall by your staff. Hosted solutions are often termed "SaaS" (software as a service), although this use of terminology can be confusing. SaaS can be used to refer to a disaggregated, cloud-based collection of software services or components that make up an entire system such as an LMS. In practice, these services are almost always hosted on the vendor's server, but they could be installed within your intranet.

Some of the advantages of a hosted platform are:

- Eliminates the cost of hardware and network infrastructure needed to support a local installation of the system
- Lowers your staff costs for administration and maintenance
- Puts less bandwidth load on the corporate network
- Content and feature updates can be accomplished without intervention by your staff
- Guarantees that system upgrades and patches are applied on a timely basis; most vendors upgrade their hosted installations on a monthly basis. Installation of updates on your server can lag significantly behind the vendor making them available, for a host of reasons.

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- Having the vendor take responsibility for upgrades and patches avoids the headaches of reestablishing your integrations, etc.
- Enables faster implementation. This can be dramatic, for instance, 3 weeks for a hosted solution vs 6 months for a behind-the-firewall solution. In some cases, software wizards are used to simplify and step users through the process.
- Requires little or no internal technical support or development
- Provide incentives and guarantees for maintaining uptime (via financial penalties assessed against vendor). You may want to independently verify uptime using a Web monitoring service. These services monitor access from multiple global endpoints. If an issue arises, your mobile phone is texted. Some monitoring services are quite sophisticated. They can actually periodically read data-driven Web-page elements to validate site availability in addition to the back-end functionality.
- Provides data center compliance (esp. in regards to data centers in foreign countries) since this is handled by vendor
- Scales more easily to account for temporary surges in usage (due to new product releases, seasonal events, etc.), due to the typical centralized system architecture usually implemented by hosting vendors, with loads dynamically shared and balanced across customer implementations.
- By virtue of the vendor taking responsibility for scaling, it eliminates the need for you to commit to purchasing and maintaining additional servers and bandwidth that may be unnecessary to support normal load during non-surge times.
- Is often associated with a usage-based pricing model (see *5.2 Pricing models*), which may be more economical
- Eliminates problem of version differences of software platforms that the LMS may be dependent on. For instance, if your company has not upgraded their Oracle license but your LMS vendor's new release depends on an upgraded version of it to run.

One of the main disadvantages of a hosted solution is that it restricts opportunities and scope for local customization (although this can be mitigated to some degree with skins. See *5.1 LMS skins and templates*). Also, a hosted solution may not provide the level of security required by your organization, although hosted solutions are increasingly more secure. One major vendor reports (DiDonato 2011b) p.27 that "…quite a few government agencies and banks are now electing to use cloud [i.e., hosted] solutions—a testimony to the [lessening of the] security issue."

The security issue relates not just to unauthorized access, but also the fact that you may be placing trade secrets and other intellectual property in your content outside of your firewall on the vendor's server, outside of your control. If your organization's policy prohibits this, a hosted solution will not be right for you. And a hosted solution is summarily ruled out if there is classified data stored in the content.

Finally, for government entities, a hosted solution may not be an option since government rules tend to mandate outright ownership and control of systems, rather than an arrangement like a hosted solution that resembles leasing.

Most hosted solution scenarios involve a single instance of the vendor's software that is engineered to support multiple customers, rather than establishing a separate instance of the software for each customer. This enables efficiencies for the vendor whereby they can apply patches and version upgrades for many customers at the same time. This lowers the operational LOE for the vendor and allows them to focus more on developing their product. Hosted systems are vendor-maintained and managed with minimal

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intervention required by the customer, so much of the headache of deployment planning relating to upgrades of the software can be avoided.

Vendors who offer hosted solutions commit themselves to a robust hosting and networking infrastructure with uninterrupted access 24 /7 basis from any location. The system that they host must be scalable and have redundant backup and security. These are items for due diligence verification during the acquisition process, if you decide to buy a hosted solution. Guarantees of average percentage of uptime are often written into the LMS service-level contract.

Hosted solutions are generally more expensive (roughly 20%) because they require the vendor to assume responsibility for maintenance and administration instead of the customer.

Figures vary for the popularity of hosted LMS solutions. They were about equal in popularity with behind-the-firewall LMS solutions, according to a 2011 study across corporate and government enterprise learning audiences (DiDonato, 2011a). As of 2012, this has risen to more than half being hosted solutions and "some vendors are reporting that cloud solutions represent as much as 75 percent of their new business" (DiDonato, 2012, p.11). Brandon Hall (2011) reports that 73% are hosted, and that this figure is rising.

You might want to use a "try before you buy" approach by using a hosted solution for a while before you decide to buy the system. Also, consider a hosted solution that is metered (pay-for-use price) rather than flat license for a maximum number of users.

When considering a hosted solution, ensure that your organization isn't already licensing ancillary software that is needed to run your LMS, such as an Oracle database. The hosted solution provider will pass through their cost for this license, which duplicates your existing (usually significant) investment. This may make a hosted solution not cost efficient for you.

On 10/13/11, Pearson Inc. announced a free hosted LMS for higher education called "OpenClass". In order to support such a free service, Pearson hopes to be able to sell more of their content (that is optimized for the OpenClass delivery ecosystem). It remains to be seen whether the idea of free hosted solutions (similar to other cloud-based software business models like Google) takes off as a real trend in LMSs.

You may want to consider outside hosting of particular types of content, especially video. For instance, YouTube® and Vimeo® allow you to upload videos, which you can then drop code into an LMS to launch. SoundCloud® can do the same thing for audio.

Be careful about free cloud-based LMS-like service providers such as Facebook. Read the terms of service carefully. There will undoubtedly be advertising, and you will need to determine how much is too much. Hidden features could include the provider selling your user lists to headhunters or spammers. Content may transfer ownership to the provider once uploaded. If you are charging your users for access, then you will probably need a commercial license.

Note: Hosted solutions are sometimes called "ASP" (application service provider) solutions. Do not confuse ASP with Active Server Pages, a programming script.

5.8 The cross domain issue

In recent years browsers have incorporated a security feature that prohibits a server with which it is communicating to connect to a server on another domain. When users point their browser to a server on a particular domain, there is a presumption of trust, and explicit choice to pull in content based on that trust. If that server unilaterally and unbeknownst to the user gets content (especially client-side scripts) from another server on another domain (that is not necessarily trusted), a hacker who has co-opted the second server can send harmful code to users (by passing it through the primary trusted server). See http://en.wikipedia.org/wiki/Cross-site_scripting for more details on this issue.

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Barring using a workaround like those listed below, the cross domain issue requires you to have your content stored on the same domain (i.e., server, usually) as the LMS. In other words, if the LMS is at www.myLMS.com, the content cannot be at www.myContent.com; the content must also come from www.myLMS.com.

This problem comes up most often in LMS implementations where there is a separate content repository server at another location from the LMS; this content repository server might be another enterprise server, or it could be a repository of commercial content behind another commercial entity's firewall. The cross domain security feature prohibits accessing the content that is on a separate domain from the LMS.

Even if it were not a problem for the user to be able to access and launch the content directly from its content repository on the other domain (perhaps through a separate LMS), the problem remains of communicating tracking information (e.g., course completion status, assessment scores, etc.) to the initial LMS.

There are several workarounds to the cross domain issue:

- Allowing the primary server to serve as a proxy to the server on the other domain (see http://developer.yahoo.com/javascript/howto-proxy.html).
- JSONP (see http://en.wikipedia.org/wiki/JSONP#JSONP).
- Cookie security (see http://en.wikipedia.org/wiki/Cross-site_scripting#Mitigation).

5.9 Special requirements for U.S. DoD

The DoD Information Assurance Certification and Accreditation Process (DIACAP) is the DoD process to ensure that risk management is applied on information systems. It certifies and accredits a DoD information system to maintain the proper information assurance (IA) posture throughout the system's life cycle. If you are acquiring an LMS for a U.S. DoD organization, it is important that you check the DIACAP certification status of any LMS you seek to acquire.

You may be subject to Service-specific requirements. These requirements speak to the "fit" of the system to the enterprise architecture of the organization (in this case DoD). These cover requirements such as:

- Security
- IT environment
- Specific use case testing
- Training gap/training needs analysis capability

One requirement that is fairly consistent across the Services is that the LMS must interface with DEERS (Defense Enrollment Eligibility Reporting System) for user verification and registration information.

Each Service often has their own training records system that the LMS needs to integrate with. For instance, the Navy often requires the LMS to integrate with NTMPS (Navy Training Management and Planning System) for personnel information and training records.

There may be particular implementation issues when installing an LMS in U.S. DoD or government, such as:

- Requirements for conducting site or pre-installation surveys
- Constraints on who can host the LMS
- Hardware, software, and firewall requirements

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- Particular government contracting rules regarding setup, startup costs, vendor support, and annual maintenance agreements

See *Appendix G: Sources of Possible Requirements for U.S. DoD LMS Acquisitions* for a list of other possible sources of requirements for U.S. DoD.

5.10 Test and staging environments

It is important that you institute at least three staging environments for your LMS, possibly on three separate networks. When acquiring an LMS, you should take this into account. Consideration of test and staging environment requirements is often an oversight until after procurement (at which point there are financial barriers to implementing it). The three environments are:

- **Development –** for content developers to upload, configure, and test their content, and for administrators to perform "what if" scenarios for major changes to the system.
- **Test** (also termed **Stage**) **–** for content and major configuration changes made in the Development environment to be verified and finally approved before being migrated to the Production environment. This instance of the system should exactly match the Production system in all respects.
- **Production** – The live system that learners and administrators use.

These environments do not have to be separate installations. Isolated areas or instances of one system can be just as effective; however, firewall restrictions and different access needs for the user groups associated with each of these environments may prohibit this.

Acquisition of these environments in addition to your production environment will probably affect pricing and your infrastructure requirements. Licensing can be complicated if external entities such as content development vendors need to use the additional instances. Special licenses may be required for them. Some LMS vendors sell packages that include these staging environments pre-configured ("sandboxes").

You need to be careful about allowing testing of new LMS versions/features/customization and testing content on the same environment or instance of it. This situation can lead to problems, where, for instance, content works well in the Test environment, but not in the Production system because they are not precisely the same.

5.11 Standards support

5.11.1 SCORM

5.11.1.1 Overview

ADL has identified the following high-level attributes for all distributed learning environments.

- **Interoperability**: the ability to take instructional components developed in one system and use them in another system.
- **Accessibility**: the ability to locate and access instructional components from multiple locations and deliver them to other locations.
- **Reusability**: the ability to use instructional components in multiple applications, courses and contexts.
- **Durability**: the ability to withstand technology changes over time without costly redesign, reconfiguration or recoding.

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To achieve these attributes in distributed learning environments, ADL promotes the use of the Sharable Content Object Reference Model (SCORM®). SCORM defines the interrelationship of course components, data models, and protocols so that learning content "objects" are sharable across systems that conform with the same model. To support interoperability, SCORM standardizes the means of communication from the sharable content objects (SCOs) to the LMS, through an Application Programming Interface (API) and prescribed data model elements.

For more information on SCORM, see www.ADLnet.gov

It is important to understand that SCORM neither dictates nor precludes any instructional, performance support, or evaluation strategy. SCORM does enable object-based approaches to the development and presentation of e-learning. This is enabled by aggregating learning content composed from relatively small, reusable content objects to form meaningful units of instruction. Individual content objects can thus be designed for reuse in multiple contexts, and aggregated variously to assemble new components and programs of instruction.

This object-based approach, intended to support reuse, means that content objects must not determine by themselves how to sequence/navigate aggregations that represent parcels of instruction. Doing so would require content objects to contain information about other content objects, which would inhibit their reusability. ADL addressed this requirement by standardizing a set of behaviors that that all SCORM-2004 compliant LMSs must support. Thus, the LMS, rather than the content, controls the movement of learners from SCO to SCO.

To support reuse, SCORM uses metadata to enable content objects to be discoverable through and across enterprises, within distributed content repositories.

NOTE: Content and systems acquired by U.S. DoD must be SCORM-conformant ("current version") according to DoD Instruction 1322.26 (June 16, 2006). See http://www.dtic.mil/whs/directives/corres/pdf/132226p.pdf for more details.

5.11.1.2 Requirements for SCORM support

For an LMS to robustly support SCORM, it must:

- Support SCORM-conformant learning delivery
- Support all SCORM data model elements (SCORM 2004)
- Import SCORM course packages
- Support SCORM metadata
- Support sequencing and navigation rules for the course organization (SCORM 2004)

If you expect to deliver legacy SCORM 1.2 content, you should ensure that the system supports it; SCORM 2004 is not backwards compatible with SCORM 1.2, so the LMS needs to include separate functionalities for importing, configuring, and delivering these two standards (generally, when you import SCORM content into the LMS, there will be separate options for SCORM 1.2 and 2004).

Before you evaluate the LMSs in terms of SCORM compliance, you should determine the target SCORM compliance level (for example, SCORM 2004 4th Edition). This depends on the compliance level of your legacy courseware, and courseware you plan to develop. LMSs can lag several versions behind the current level, and since SCORM levels are not all backward compatible, it is important to determine the level of compliance needed for your course delivery system.

SCORM comes in five versions:

- SCORM 1.1

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- SCORM 1.2
- SCORM 2004 2nd Edition
- SCORM 2004 3rd Edition
- SCORM 2004 4th Edition (the current version)

Conformance with SCORM 1.2 is broken down into three levels, LMS-RTE1, LMS-RTE2 and LMS-RTE3. The levels indicate how much of the SCORM run-time data model the LMS supports. LMS-RTE3 indicates full support.

ADL highly recommend that you acquire a sample SCORM-conformant e-learning course produced by the authoring tool you use, and test it on the LMS you are evaluating for purchase. LMSs implement the same SCORM compliance level differently in some cases; the interaction of the particular implementation of SCORM in the LMS and the particular implementation of SCORM in your SCORM course package, even if both are at the same level of compliance, may uncover issues. This may impact your decision to purchase a particular LMS.

Brandon-Hall reports (10/11) that 83% of the 132 LMS they track are SCORM 1.2 compliant, and 56% are SCORM 2004 compliant (Brandon-Hall Research, 2011).

5.11.1.3 SCORM Conformance vs Certification

An LMS that is SCORM conformant has been tested in the ADL SCORM Conformance Test Suite to ensure that it performs as specified by the SCORM standard. This test applies to a specific version of SCORM only. The ADL SCORM Conformance Test Suite is available at http://www.adlnet.gov/Technologies/scorm/SCORMSDocuments/2004%204th%20Edition/Test%20Suite.aspx).

An LMS that is SCORM certified means that a qualified, neutral third party has conducted a formal evaluation using the ADL SCORM Conformance Test Suite using a rigorous, accurate, reliable, validated methodology. Certified products display the ADL certified product logo. There is a list of SCORM-certified LMSs on the ADL web site at http://www.adlnet.gov/Technologies/scorm/Custom%20Pages/Certified%20Products.aspx. For details on upcoming changes to the SCORM certification program, see *Appendix H: Update on the SCORM Certification Program for LMSs*.

If you are considering products that claim to be SCORM conformant but are not SCORM certified, you should ask for an ADL SCORM Conformance Test Suite test log from the vendor verifying their SCORM conformance. Alternatively, you can run this test yourself if you have access to a version of their LMS. A product that cannot pass the full set of conformance tests is not SCORM conformant.

ADL recommends that you write into your contract or acquisition language that the vendor will maintain SCORM conformance/certification throughout the life of the contract. You do not want to be stuck in a situation where the vendor issues a patch, upgrade, or new release that interferes with the ability of the LMS to deliver SCORM, and your SCORM content suddenly does not run properly (with no recourse to force the vendor to fix the problem).

Be aware that, in the past, there have been loopholes in the certification process whereby vendors can maintain their SCORM certified status, even though their LMS has undergone version upgrades, patches, etc. that inadvertently affect their SCORM engine, with the result that SCORM content no longer works properly in their LMS. ADL is revising the rules for the certification program to address this loophole.

Dig deep into claims of SCORM compliance. If the LMS has an internal authoring tool, it may mean that the product can import a SCORM package into the authoring tool, but the authoring tool converts it into the LMS's proprietary format in order for it to work in the LMS. In other words, you may not be able to

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import SCORM content directly into the LMS and have the content function natively (using SCORM affordances) within the LMS. This is not true interoperability in the spirit of SCORM.

You may want to ask the vendor whether they participate in the process of evolving the SCORM standards, and if so, how. ADL has a variety of community outreach avenues that enable vendors to share suggestions and keep abreast of SCORM developments. This is a good indicator of the vendor's commitment to support for the SCORM standard.

NOTE: LMSs for U.S. DoD installations must be SCORM-conformant (to the "current version") according to DoD Instruction 1322.26 (June 16, 2006 – this DoDI, as of this writing, is being revised, although it is likely that this requirement will still remain in effect). See http://www.dtic.mil/whs/directives/corres/pdf/132226p.pdf for more details.

5.11.2 Section 508

The U.S. Rehabilitation Act of 1973was amended in 1998 to add Section 508, which establishes rules, principles, and guidelines to make it easier for people with disabilities to access electronic and information technology media. The law applies to all Federal agencies when they develop, procure, maintain, or use electronic and information technology.

If your organization requires Section 508 compliance for e-learning systems, it is critical that you include this as a decision parameter in your choice of an LMS. Do not confuse Section 508 compliance for the LMS with Section 508 compliance for the content; 508 compliance for the LMS means that the interface and navigation through the LMS is accessible to those with disabilities (especially visual impairments). Where 508 compliance is required, the content must also be 508 compliant, but LMS compliance does not affect or control this.

You should verify 508 compliance by testing the LMS with screen reader software used by those with visual impairments and/or using an independent accessibility checker (see http://www.rnib.org.uk/xpedio/groups/public/documents/PublicWebsite/public_tools.hcsp)

For references and other information on Section 508 compliance, see http://www.section508.gov/

5.11.3 Aviation Industry CBT Consortium (AICC)

Support for this popular standard is fairly common among LMSs. Note that the standard is used by many more organizations than the aviation industry. One reason for the popularity of the AICC standard for content is that it avoids the cross domain scripting problem (see *5.8 The cross domain issue*). There are several different implementations of AICC:

- File-based
- HTTP (Web)-based
- ECMAScript-based (browser-based)

In most cases, the term "AICC" refers to the HTTP-based implementation known as HACP (HTTP AICC Communication Protocol). If AICC support is important to you, you may want to ensure that it supports HACP to ensure broad content compatibility.

See http://www.aicc.org/ for more information.

Brandon-Hall reports (10/11) that 87% of the 132 LMSs they track are AICC compliant (Brandon-Hall Research, 2011)

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5.11.4 Standards for metadata

Some of the standards that are used specifically for metadata in e-learning are the following:

- IEEE Learning Object Metadata (LOM)
  http://www.imsglobal.org/specifications.html
- Dublin Core
  http://www.dublincore.org/

Support for a particular metadata standard in an LMS is not needed unless the standard has been fully adopted by your organization. If the metadata standard has been adopted, LMS support for it will facilitate search, discovery, and cataloging of your e-learning and other content objects in your LMS. In a large enterprise with many learning objects, this may represent a significant savings of time and effort. Metadata normally resides within the content itself and is imported into the LMS database when the course files are imported.

Note that SCORM does not prescribe use of metadata, or any particular metadata standard. However, the ADL Registry (ADL-R) uses a subset of the LOM. In order to be most compatible with the ADL-R, if you are registering objects, you should use the LOM and look for LOM support in your LMS.

5.11.5 Common Cartridge®

IMS Global Learning Consortium developed Common Cartridge® as a standard way to package a course for importing to an LMS. It has many of the same advantages as the SCORM packaging specification (Content Aggregation Model). If you are importing and delivering courses that are packaged using this specification, you need your LMS to support it. See http://www.imsglobal.org/cc/index.html for details on this standard.

5.11.6 QTI®

The IMS Question and Test Interoperability specification (QTI) is an interoperability specification that specifically relates to online tests. It is concerned with the structure and display of test items as well as results. It allows passing of data between authoring systems, content, and delivery systems, including LMSs. See http://www.imsglobal.org/QTI.html for details on this standard.

5.11.7 Training and Learning Architecture (TLA)

ADL has termed the next generation of SCORM as the Training and Learning Architecture (TLA). All current and planned future ADL technical projects, specifications and standards efforts fall within the scope of the TLA, an umbrella term that covers projects designed to create a rich environment for connected training and learning. Phase I of the TLA is focused on experience tracking that includes these four areas:

- A new runtime API
- A new data model
- A new data model format/syntax
- A new transport/communication method

The overall TLA vision also includes concepts for learner profiles, competencies, and intelligent content brokering to meet the needs for individualized learning content and systems. The TLA is not intended to replace SCORM, but SCORM, and multiple other types of content formats, will work in the TLA. The four components of the TLA are:

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- Experience tracking
- Learner profile
- Content brokering
- Competency infrastructure

The Experience API (formerly known as the 'Tin Can API'), the "experience tracking" component described above, is the farthest along in development currently. The Experience API tracks both formal and informal learning via 'streams' of learning experiences, similar to social media streams such as Twitter and Facebook. By capturing learning experiences via streams, learning can be mashed up with other activity data to fully analyze how it ties to performance. The new API enables the use of mobile devices, games, social networks, virtual worlds, and simulations in learning and training environments with the ability to track learning experiences consistently across devices and platforms. You could report that 'David watched a video,' 'David rated a video,' 'David tweeted a video,' and 'Jane retweeted David's video.'

Learning can also be tracked in real life situations and reported the same way. For example, 'John produced an audio track for a video,' 'Steven edited a video,' 'Ralph posted a video,' and 'Mary earned an Academy Award for a video.' This is why we describe this as "connected" learning, because even "real life" situations can be connected in more ways than just how people interact with computers on the Internet.

For more information on the TLA standard, see http://www.adlnet.gov/introducing-the-training-and-learning-architecture-tla. There are currently 25 planned adopters. The Experience API is currently at version .95 (alpha pre-release). The version 1.0 release is scheduled for Q1 2013.

5.12 Internal assessment authoring

ADL recommends that you create assessments within the content so that they are portable and interoperable; however, in some cases, you may want to be able to create assessments through tools offered within the LMS. Many LMSs offer this. The vast majority of LMSs offer internal assessment creation and delivery capabilities. The downside to using this internal authoring function for assessments is that these assessments are often permanently resident in the LMS and cannot be exported for use in another system or with other content.

Assessment authoring within the LMS may be attractive because assessments must interwork closely with the LMS tracking database. It is often quicker and easier for LMS instructors and administrators to use an internal LMS function rather than create external assessments with the appropriate data calls. Also, assessment interactions can be more difficult to program than presentation content, so it avoids this technical burden on the customer as well.

Use of internal assessment authoring is particularly common in cases where learning activities are conducted offline and cannot be assessed and tracked by the LMS while the student completes them. Thus, an LMS-delivered assessment is the only way to verify and store the student's progress against outcomes, and it is easier to author these assessments internally in the LMS. The standard types of e-learning assessments that are offered are:

- Multiple choice (both single and multiple answer)
- Fill in the blank
- Matching
- Drag and drop

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- Ranking/Ordering
- Image selection
- Essay or Short answer (this requires instructor intervention to score answers)

Some LMSs import and export assessments that adhere to the QTI specification (described in *5.11.6 QTI*), which allows portability of the assessments between systems.

5.13 The path of least resistance

It is important to remember the simple fact that most users, in many cases regardless of their skill set, will follow the path of least resistance in using an LMS, as with any other software. In other words, users will gravitate towards the most heavily optimized system features—those that are prominently available in the interface and easiest to manipulate. The system may include many advanced capabilities, or even easy workarounds or hacks that are possible to accomplish highly time-saving tasks, but most users will ignore these if they are not designed to follow the path of least resistance.

So the question is not necessarily, "What can the system do?" but, "What can the system do in a right-out-of-the-box, plug-and-play, easiest/most-obvious-path use case scenario?" Just because a vendor is able to make a technical case that their system has a particular capability doesn't mean that it is implemented in a way that is easy for users to see, understand, and use.

5.14 Aligning staff and processes to system capabilities

As with most software, systems that are easier to learn and use have fewer capabilities, and vice versa. Sophisticated capabilities will generally require a system that is harder to learn and/or require specialized professional expertise. It is important to determine the skill sets within your pool of LMS administrator staff, so that you know what you are prepared for and/or what you might have to acquire in terms of staffing or training. You can engineer your staff expertise and roles to match the out-of-the-box system, but it is usually not cost-efficient to engineer the system to match staff expertise.

This also applies to task flow; you will almost invariably need to decide whether you want to change your internal processes to match the built-in LMS task flow, or vice versa (i.e., reengineer the LMS to match how your organization does things). This is a complex issue, and there are some strong proponents on the side of choosing an LMS that, out of the box or perhaps with customization, supports your existing processes, but this may be easier said than done. It is likely that you will have to do some of both. Above all, do not underestimate the financial pressure you may find yourself under to tailor your organizational policies and processes to make it easiest to work with the system out of the box. Customization of LMSs, whether open source or commercial products, can be quite expensive.

6. Criteria for assessing quality and suitability of LMSs

The following is a list of characteristics, features, and functions that a robust LMS should include. The applicability of items in this list to your situation will probably vary widely; some items may be mission-critical for your organization and some may not be pertinent at all. You need to carefully weigh the importance of each in evaluating LMSs. If you rate your list of LMS candidates simply by all items in the list without weighting each item for its importance to you, it could skew the results, which could lead to a poor final choice for your system.

There is also the issue of the degree of support that the LMS provides for a certain feature. Very few of the features listed below are either 100% present or 100% absent in a given LMS.

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Because LCMSs incorporates additional content authoring and repository functions, other criteria are applicable for LCMSs in addition to the criteria presented in this section. See *Appendix I: Additional criteria for assessing quality and suitability of LCMSs*. Further, if you are looking at an LCMS solution, you will need to focus on the quality of content authoring features. For a list of quality criteria related to authoring capabilities, see ADL's *Choosing Authoring Tools* paper at http://www.adlnet.gov/capabilities/free-trial-demos#tab-learn (see paper listed under **White Papers** in **Resources** section).

A high-quality LMS has the following characteristics:

- **Registration and enrollment functions and workflow**
    - Uses a straightforward, simple process for learner registration/enrollment.
    - Allows learners to auto-enroll for courses.
    - Automatically places learners in wait lists if courses are full, with automatic notification to affected stakeholders.
    - As a configuration option (where courses are not mandatory) allows students to select, register and remove courses or curricula from their course listing/learning track on their own with no supervisory or administrator intervention.
    - Displays visual interface options such as map and tree metaphors to enable clear understanding of the organization of curricula and easy course selection within them.
    - Incorporates clear navigation and search options within course catalogs to find and register for courses.
    - Allows registration and enrollment based on multiple memberships. For instance, a user is a member of the HR division but also a Level 2 supervisor; they are assigned courses based on both of these memberships.
    - Manages recurring training such that learners are auto-enrolled at the appropriate intervals.
    - Allows training managers and instructors to enroll and/or approve enrollments for learners. Approvals should have due dates associated with them.
    - Saves of sets of configurations as templates that can be applied to future courses.
    - Routes enrollment requests to instructors.
    - Interfaces effectively with HR systems to provide user lists, to automatically add new users and deactivating users who have left the organization. Manual maintenance of user lists can be labor-intensive and complex.
    - Links and/or enrolls learners in appropriate courses or curriculum automatically based on organizational requirements.
    - Can flexibly store and report course credits in different number formats, from whole numbers down to decimal places. Some organizations that license and certify professionals offer courseware that needs to be tracked at the level of two decimal places, for example, 2.75 credits.
    - Allows setting course allotments and prioritizing learner enrollments to courses based on them.
    - Includes instructor cadre management. This includes managing instructor qualifications, classes authorized to teach, and resource alerts to prevent over-booking scheduling.

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  - Allows administrators to easily override settings made for groups to account for particular training needs of individuals.
  - Allows a variety of billing options: credit card, corporate purchase orders, departmental account numbers, etc.
  - Automates tuition assistance requests and allow for supervisor and other administative approvals of these in the system. This includes automating tuition assistance verifications after courses are completed.
  - Provides the ability to print a variety of enrollment-related items, including class schedules, seat vacancies, and class rosters.
  - Manages registration and enrollment not only by individual, but by group and cohort group.
- **Notifications and annotations**
  - Notifies users when actions are taken in the system that affect them, both through system notification functions and by e-mail. This includes such actions as:
    - Change in user profile status
    - Change in course status
    - Confirmation of enrollment
    - Class cancellation
    - Being wait listed for a course
    - Learner dropped from class
    - Periodic reminders to attend or finish courses
    - Reminders to complete a survey
  - Sends reminders about certifications that are about to expire (so that they can renew).
  - Provides the ability to annotate and communicate actions taken, approvals, errors, etc. in regards to administrative actions, for future reference or for other administrators.
- **Batch administration workflow**
  - Offers batch options for tasks involving groups of system objects.
  - Allows administrators to batch register of groups of learners.
  - Allows administrators to batch set permissions and roles for users.
  - Allows administrators to batch configure courses, learning tracks, and curricula.
  - Allows time shifting of batch processes of database or processor-intensive tasks to minimize performance disruption during peak usage times.
- **Prerequisite handling**
  - Allows administrators to set prerequisites so that learners are evaluated for meeting prerequisites before being able to enroll in a course.
  - Can be configured to deliver pre-assessments to allow learners to “test out” if they demonstrate mastery of the material for a course.
  - Includes options for configuration of waiving course/curriculum requirements based on demographic attributes other than course completion or pre-assessments.

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  - Establishes equivalencies so that learners can receive credit for courses and/or waive the requirement to take courses that share the same material as a course already taken.

- **Content importing and configuration**
  - Provides an easy, powerful, and intuitive process for importing and configuring content.
  - Provides the ability to internally create and/or configure ancillary learning objects like glossaries that can interwork with courses and apply globally to more than one course within the LMS.
  - Is interoperable with 3rd party content (if applicable). If you are delivering courses provided by a commercial provider (for example, Skillsoft® or element k®), you will need to ensure that the content operates effectively within the LMS you are acquiring. This characteristic is supported through the use of standards and specifications such as SCORM and Common Cartridge (mentioned in *5.11 Standards support*).
  - If the LMS is interoperable with 3rd party content (see above), it offers flexible, secure, and user-friendly payment options such as PayPal®.
  - Imports course packages of unlimited size (especially important if your e-learning contains rich media, or courses are very long).
  - Allows elements of a course to be updated without creating a new version of the course (for instance, swapping out the SCORM manifest file without having to upload an entire replacement course package).
  - Presents options to automatically move learners to a new version of a course when a new version of it is created, or allows them to continue on the old version. This has implications for progress data; you do not want learners to lose existing progress data if they are half way through the course. For minor changes to the course, learners should be able to seamlessly experience the updated content with no interruption in their learning flow. However, for major version updates, it can be very hard for an LMS to move users to the updated content while maintaining their progress information.

- **System access**
  - Uses robust security architecture to maintain system access.
  - Allows learners to self-register for an LMS account.
  - Provides a single sign-on, so that users who have logged in to the enterprise intranet (through a portal, etc.) can get into the LMS without additional login.
  - Allows login to the LMS to transfer to other enterprise systems (especially HR).
  - Requires user logon only once per LMS session.
  - (for high-security government installations) Uses Common Access Card (CAC) access.
  - Incorporates appropriate security certifications and standards, and features (see *5.6 Security considerations for LMSs* and *5.9 Special requirements for U.S. DoD*). Other security standards you may need include SSL, PKI, and FIPS – 140-1.
  - Allows configuration for the management of personally identifiable information (PII) in accordance with enterprise policy.

- **Permissions and roles**
  - Defines a wide variety of permission and role levels that are applicable to a range of organizational structures and use case scenarios for the system.

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- Restricts course enrollment to pre-authorized learners.
- Incorporates permission levels and supporting features that allow input of SME review comments that are tagged to screens, with search and filtering capability. (this is usually only found on an LCMS)
- Uses templates to easily set group permissions.
- Restricts access to functions for individual courses based on membership on teams associated with that course.
- Allows delegating permissions for users at a lower level of permission than what one is logged in as.
- Allows creation of subgroups that inherit permissions of parent groups.
- Can be set so learners are anonymous to each other, instructors, and administrators.
- Offers "organization aware" features that allow administration based on external data feeds concerning organization roles and permissions.
- Supports mirroring an organization's structure in the database to manage students, supervisors and approvers based on where they exist within the organizational structure.
- Features levels of permission corresponding to clearly defined levels of administrative responsibility. For example:
  - Level 1. – Overall responsibility for system
  - Level 2. – Database Administration
  - Level 3. – Maintenance administration of the system. This permission may be segmented to allow users only to perform particular maintenance tasks or for particular user groups.
  - Level 4. – Curriculum administration. This permission may be segmented to allow users only to perform particular tasks for certain curricula and/or with certain groups of learner.
  - Level 5. – Content administration. This permission may be segmented to allow users only to perform particular tasks on particular courses.
  - Level 6. – Authoring capabilities (for LMSs that have this function)
  - Level 7. – Learner

- **System performance**
  - Performs with minimal latency under a variety of use case scenarios and load conditions.
  - Handles large numbers of concurrent users.
  - Handles user load efficiently, provisioning and scaling resources to smoothly accommodate fluctuations (especially spikes) in numbers of concurrent users.
  - Works equally well (all functions, including course delivery) on all standard Internet browsers.
  - Has reasonable system requirements that are attainable within your organization.
  - Uses normalized architectures for hardware and software implementations.
  - Can be load balanced across multiple servers.
  - Can be clustered

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  - Has robust mechanisms for coping with machine failure

- **Course catalog database**
  - Provides a single, integrated or multiple course catalogs whose overall and internal organization can be flexibly defined by a variety of characteristics.
  - Does not arbitrarily limit the number of levels, items, or sizes of items included in the catalog of courses delivered or imported.
  - Contains a course catalog including many details of courses, especially:
    - Objectives
    - Credits
    - Course #
    - Cost
    - Associated career track(s)
    - Associated competencies
    - Delivery method
    - Prerequisites
    - Functional area
    - Location (if synchronous)
    - Job skill
    - Product line
    - Subject
    - Associated resources
    - Seat time
  - Provides search capability, including by all of the above in addition to keyword.
  - Provides the ability to search for text within courses.
  - Can be linked dynamically to external catalogs (for instance, from COTS content providers).
  - Can be updated with release updates and additional courses from external sources.
  - Provides version control and other management functions for course updates.
  - Can be configured such that different versions of the course that are treated functionally the same for training administration purposes (for example, the same course delivered in different languages) use the same reference ID in the LMS database. In other words, the LMS tracks and reports that learners have taken the same course, even there are different language versions.

- **Interface customization**
  - Allows visual branding of the interface for all users in the enterprise.
  - Allows use of skins to visually brand the LMS dynamically according to the role, organizational membership, or other parameters of the individual user who is logged in. See *7.6 Instantiation for individual business units*.

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  - Allows toggling display of the LMS Table of Contents (TOC) for a course, so that courses with no need for this (for example, courses with just one SCO) vs SCORM courses with many SCOs (and thus a need for good inter-SCO navigation).

- **Standards and language support**
  - Supports the current and all required legacy versions of relevant standards such as SCORM. See *5.11 Standards support*. For details on what is required for full SCORM support, see www.ADLnet.gov.
  - For SCORM content:
    - Is certified at the level of your content, or has been tested for conformance. Do not rely merely on vendor advertisements of their conformance.
    - Retains visibility for the TOC when a SCO has been launched.
    - Shows both "attempted" status as well as "completion".
    - Is not overly proprietary in its implementation and handling of SCORM calls other than "attempted" and "completion."
  - Complies with Section 508 requirements for system interfaces.
  - Supports multi-byte (Unicode) fonts (esp. Asian language characters) and right-to-left languages. This requires that the LMS interface text is stored as data, separate from source code.
  - Offers flavors of the interface in foreign languages for global reach.
  - Supports the Training and Learning Architecture (TLA). See *5.11.7 Training and Learning Architecture (TLA).*

- **Training infrastructure and performance analysis**
  - Includes the ability to enter and capture such items as course development costs.
  - Provides support for student surveys and training needs surveys.
  - Includes training budget/cost tracking and projecting features that stores and reports (by learner, course, organization, year, etc.) such items as:
    - Budget authorizations
    - Funds allocated
    - Funds still available

- **Learning object management**
  - Allows attaching, associating, and consolidating diverse content pieces into a single course (for example, core course content delivered as e-learning with auxiliary PDF and video resources included separately).
  - Includes ways to link content and assignments in blended learning courses so that it is clear that the components are part of a single course and can be assessed and tracked as such.
  - Is optimized for reusability in general (not just measured by SCORM support). Some LMSs have their own internal content repository that allows internal mixing and matching of objects in designing a course, curriculum, or learning track.

- **Delivery architecture**

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- Supports a wide variety of delivery architectures. For instance, an e-learning architecture involving a content repository that may be on a different server than the LMS and is supplied by another vendor.
- Can be configured (via proxy server, etc.) to avoid the cross domain scripting issue so that courses not residing in the LMS domain can be launched. This includes launching courses from content repositories in different locations within the corporate intranet, as well as on the Internet.
- Can provide an audit trail for required deployments of mandated training (for example, compliance training).
- Provides integration with social networking services (e.g., Facebook, Twitter).
- Allows delivery of a wide variety of content in diverse file formats for delivery to learners as either embedded into the e-learning or separate learning objects.
- Has offline player capabilities (see *5.5 Offline player capability*).
- Offers a browse mode whereby testing requirements are suspended (for learners who have already taken the course). This may be handled through content functions or standards like SCORM.
- Allows quick and easy access and launch of short, just-in-time performance support modules. The process of finding and launching these should be easier than normal e-learning since users will often need to launch these while performing a job task; they should not be demotivated to do so by a cumbersome process. These are normally handled differently from regular e-learning courses for this reason, and because they do not normally include assessments.
- Launches courses cleanly and easily, regardless of their source (COTS or Gov't developed, LMS server or other server).
- Includes configuration management and version control features for content. This includes, for example, checking files in and out to prevent accidental overwriting, and revision tracking to audit changes and roll back to earlier versions.
- Supports delivery to mobile devices.
- Permits bookmarking locations in courses and other content and storing favorites to particular screens in the LMS.
- Includes a user system requirement checker that tests learner systems for appropriate plugins (and versions) before courses are launched. The LMS should not allow you to launch content unless it passes the test.
- Opens a minimum of windows to deliver courses. Some LMSs open chains of 3 or 4 browser windows just to deliver a simple course. If the user inadvertently closes one of these windows, it may cause the course to stop functioning.

- **Cost**
  - Costs less for the base application license compared to the cost of other similar systems with similar capabilities and feature sets. This includes all TCO (total cost of ownership) costs. As described in *3. Process for choosing an LMS*, systems range from $14,997 – $1.6M for a hosted LMS solution for 25,000 users with a 3-year cumulative license; the mean price for such a system is $493K, and the median price is $323K (Brandon-Hall, 2011).

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- Has a licensing agreement that is flexible and easily scalable to reflect changing numbers of learners and administrators. This is especially important if you project substantial growth in your organization.
- Allows you to meter usage of the system by individual business units, so that you can spread the cost fairly.
- Costs less for recurring and ongoing support compared to the cost of other similar systems.
- Costs less for the database (if included separately) compared to the cost of other similar systems.
- Is projected to cost less for required customizations compared to the cost of customizations for other similar systems.
- Costs less for add-ons such as APIs to external applications compared to the cost of other similar systems.
- Offers hosted and/or component-based architecture solutions to take advantage of these potentially cost-saving options (see *5.7 Hosted solutions* and *7.11 Component-based architecture* for details).
- Costs minimally extra for separate test and staging instances of the product (see *5.10 Test and staging environments*).
- Uses or can use open source components (e.g., MySQL) that can significantly reduce costs.
- Has a vendor who is open to cost sharing arrangements. If you are planning to make extensive customizations, discuss with the vendor possible partnering on the development and/or cost of such changes so that the cost or development can be shared with the vendor and/or other customers, if other customers who have purchased the vendor's product will receive the new functionality. It is standard practice for vendors to use customer requests for customization as an economic basis for their development of new system features, such that the cost of developing these features (that are included in system upgrades that everyone gets) is effectively funded by these customers.

- **Assessment authoring**
  - Provides an internal function to create and deliver a wide variety of assessment types (with template options). See *5.12 Internal assessment authoring* for more details.
  - Can export assessments created within the LMS for use in other content or LMSs. Assessments created in the system must be interoperable (using a standard like the SCORM cmi.interactions data element) in order for this to happen.
  - Includes a grade book function for instructor-led courses.
  - Provides a rating or assessment function for mentor/coach/OJT assessments.
  - Has flexible options for establishing how and when the assessment is delivered (e.g., as a self-check quiz, or end of course test).
  - Allows input/upload and management of essay questions.
  - Can be configured to remediate students to particular content or locations in content based on assessment results.
  - Allows importing sets of questions formatted in a standardized format (e.g., QTI).

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- Randomizes the order of questions within an assessment and the answers within a question.
- Allows creating pools of questions per objective, such that different items can be presented in subsequent student tries (i.e., students won't see the same question twice).
- Allows assigning weights to individual answer choices for assessment elements, so that it:
  - Gives learners partial credit for correct answer chosen in an assessment element with multiple correct answers
  - Penalizes learners more for answers that are obviously incorrect
- Allows customizing hints and feedback
- Assessments can be set to either practice or test mode
- Allows export of assessments to Word (for printing)

- **Mentoring, coaching, and other developmental scenarios**
  - Supports management (assigned on an individual or class basis) of:
    - Mentoring
    - Coaching
    - Groups
    - Projects
    - OJT
    - Shadowing and apprenticing
    - Rotational assignments
    - Career programs
    - Conferences/forums/seminars/workshops

- **Collaboration and communication options**
  - Allows learners to take notes as they interact with learning materials. These notes should be persistent between sessions and automatically associated with locations in the content. If the learner wishes, their notes can be posted, either internally in the LMS, or publicly outside of the LMS, through APIs to applications like Twitter and Facebook.
  - Includes collaboration functions to enable users to communicate with each other, instructors, course administrators, system administrators, etc. These functions typically include:
    - Email (including group lists)
    - White boarding
    - Chat
    - Blogs
    - Microblogs
    - File sharing
    - Threaded discussion (aka forums or discussion boards)
    - Desktop sharing
    - Community calendar
    - Social networking

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        - Instant messaging
        - Student-created personal web pages
        - Communities of practice (CoPs) or dedicated team spaces. Members/teams can be comprised either of learner cohorts taking the same course, or functional teams within the organization.
        - Surveys
        - Peer rating of content
        - Webcasting, with the ability for learners to initiate sessions among themselves (i.e., not just one-way, instructor to learner webcasting)
        - Learner to learner whiteboard (ie, not just instructor to learner)
        - Learner posting of web pages
    - If file sharing is provided:
        - Allows learners to include comment tags
        - Allow check-in and check-out version controls
        - Incorporates a user rating system (for relevancy, quality, etc.)
    - Provides specific functions that enable learners to provide feedback on the content.
    - Provides a variety of asynchronous distribution mechanisms for content, including email attachments, RSS feeds, and podcasts.
    - Provides the ability to display a welcome message upon user login, with info on where to get plugins, announcements of new content, etc.
    - Includes online conferencing capability (this is standard for VLEs, but not for LMSs).
    - Includes logistical communication functions such as a course calendar and learning assignment pages. Calendars should filter items for relevancy to the role of the person logged in.
    - Effectively manages authorization/authentication; manages access to materials and conferences.
    - Provides social media learning functions that can be integrated into the curriculum to provide social media-based learning assignments. See *7.2 Support and optimization for social media* for more details.

- **Competency management and development/learning plans**
  (**NOTE**: many of these are beyond most LMS capabilities as of this writing. They are included here to guide you as to what advanced features you might want to look for. For information on these features as an emerging trend, see *7.9 Competency analysis tools*).
    - Supports competency management and Individual Development Plan (IDP) HR enterprise infrastructures.
    - Automatically links training interventions and competency objects based on user approval.
    - Features advanced natural language matching algorithms and associated linking functionality.
    - Allows students to create and manage e-portfolios
    - Maps individuals/groups to a course/curriculum dynamically based on rule sets determined by enterprise requirements.

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- Operates as a standalone product, so that linking training interventions to competency objects can be performed off-line and then ported to the LMS.
- Uses a variety of competency frameworks, providing a range of choices for methods of measuring competencies (for example 360-degree Feedback).
- Uses a variety of competency rating scales.
- Includes built-in Update functions to reconcile linkages due to changes in training interventions or competency objects (additions, deletions, or just word changes).
- Imports/exports competency-related data in common database formats such as XML or MS Access.
- Can provide IDP progress, training completion, and other related input to competency management, performance appraisal and other HR components of other systems.
- Can provide automated analysis/assessment survey of employee's current and anticipated skills and competencies. Gaps are identified with appropriate courses indicated to address closure of gap(s).
- Prioritizes competencies and courses based on changes in career, regulations, funding, or organizational vision/mission.
- Can import competency inventories and rubrics as well as learner data from external systems.
- Supports individual development plans (IDPs) with the following options:
  - Dynamic IDP that is updated as employee registers, attends, completes, or does not complete approved training.
  - Certification/recertification schedules and notification.
  - Competency decay refresher.
  - Mandatory/optional training requirements.
  - Ad-hoc/emergent training requirements.
  - Full reporting capability.
  - Compatibility with any competency framework.
  - Compatibility with any competency rating scale.
  - Performance thresholds (times to complete).
- See *7.9 Competency analysis tools* for more details on competencies.

- **Learner tracking**
  - Capable of tracking, reporting and storing a wide range of student performance data by individual, by group and by cohort groups.
  - Includes the ability to add custom fields to track additional learner information, so that they can be included in analyses and reports.
  - Tracks accredited learning units, for instance, continuing learning units (CLUs), continuing education units (CEUs), and continuing professional education (CPEs).
  - (for government installations) Includes the ability to "federalize" data to store SSNs (encrypted), name, CPOID, Activity, Organization, Pay , Occupational Series, Grade and other identifying government information. Note that this information is subject to Personally Identifiable Information (PII) restrictions; the LMS should have security

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measures in place to protect it. See http://csrc.nist.gov/publications/nistpubs/800-122/sp800-122.pdf

- Provides the ability to print a variety of tracking-related items, including test scores.
- Can track a wide variety of relevant items, including:
  - Enrollments
  - Withdrawals
  - Launches
  - Completions
  - Competencies acquired
  - Use of materials
  - Evaluations
  - Grades
  - Assessment scores
- Allows a learner to view their own online course results on a lesson-by-lesson basis as well as:
  - Time spent
  - Date and time last accessed
  - Number of test tries
  - Course grade

- **Certificates, forms, and surveys**
  - Allows administrator design/upload and learner delivery of course completion certificates.
  - Includes electronic signature capability on external form(s), for example, the government SF-182. Signature features for government installations should include SSL, PKI, and encryption for all authorizing levels.
  - Allows easy printing of certificates, surveys, and evaluations.
  - Provides survey functions as follows:
    - Create and edit
    - Import
    - Copy
    - Define properties
    - Preview
    - Define survey link location (for embedding survey in eLearning, website, sending by email, etc.)
  - Has different options for design of surveys, such as multiple choice, Likert scale.
- **Interfaces with external systems and applications**
  - Includes data migration tools for moving data permanently from a legacy system to the new one
  - Interfaces with systems that you might have in your enterprise such as:
    - HR systems
      - HR database
      - Performance management system
    - Enterprise resource planning (ERP) systems such as such as SAP®

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        - Learning systems
            - Student registration system
            - Collaboration tools
            - VLE
            - CMS
            - LCMS
            - Electronic libraries
            - Third party course content
            - Another LMS or system that you will need to import legacy learner tracking data from
        - IT administrative systems
            - Authentication systems
            - Authorization systems
            - Data validation systems
            - Email directories
    - Imports and exports to external systems in real-time and batch mode. This data typically includes not only student demographics and identification but such things as competencies, certifications, and IDPs (individual development plans).
    - Enables add-ons and integration using an open architecture (see *7.3 Open architectures* for more details).
    - Import and export of learner and course tracking data using standardized data interchange formats (e.g., XML, CSV) without writing high-LOE integration applications.
    - Interworks with other systems that manage and deliver training, such that content can be accessed on another system (for example, an LCMS's content repository).
    - Has the ability to call external applications and code objects (such as calculators and random number generators), and set up interfaces to read and write from databases.
    - Is interoperable with a variety of authoring tool(s), including direct import from the authoring tool into the LMS. It is important that you determine which tools your content authors prefer to use and ensure compatibility with those tools.
    - Includes "widgets" (add-ons) that allow the learner to access search engines, maps, social media sites, etc.
    - Includes automatic student registration of new hires based on data that is input to HR system.
    - Links to employee records in the external system.
    - Deletes student ID and training records when employees terminate based on action in the external system.
- **Metadata support**
    - Supports the kind of metadata your organization uses (LOM, Dublin Core, etc.). See *5.11.4 Standards for metadata* for more details.
    - Includes a convenient mechanism for adding metadata or descriptive labeling to not only courses, but also to other objects (SCOs, files, activities, etc.).
    - Uses metadata to search the course catalog(s).

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  - Presents options for display of metadata to learners and administrators at relevant nodes in their workflow.
  - Allows configuring how metadata tags will be input by content developers (checkbox, date, popdown, text box, etc.)

- **User profiles**
  - Has the ability to manage profiles for organizations, not just users.
  - Has the ability to matrix learner characteristics demographically, organizationally, etc. (for example, assign students to more than one job role, in more than one organization).
  - Can be searched on any field.

- **Reports**
  - Offers a wide variety and number of predefined reports.
  - Offers flexible, robust abilities to create custom reports, both internally and by using external tools (including those supplied by other vendors such as Crystal Reports®).
  - Prints reports easily, with appropriate options.
  - Provides capabilities to:
    - Administer and maintain performance and evaluation metrics.
    - Track individual and group usage statistics.
    - Integrate evaluation forms internal and external to the courses.
    - Perform statistical analysis on the database information.
    - Report on learner performance data by individual and group.
    - Easily perform summative evaluations of courses
  - Provides direct access to tables used within the LMS for developing queries and reports. This should be documented in table and data structure specifications provided with the product. This is usually a requirement for government installations.
  - Provides reporting on certification status of groups and individuals, including upcoming renewals, missed renewal deadlines, etc.
  - Provides ways to incorporate data from external systems to produce reports and analytics that show “big picture” measures of employee learning progress activity across all knowledge transfer mechanisms.

- **Ease of use for administrators**
  - Is easy to learn and use, with the ability for users to choose from tiers of features according to the knowledge and expertise of the user. This allows users to start using the program quickly and gradually progress to more complex authoring tiers/feature sets as their skills mature. In other words, users only see features that are relevant to their level of skill and the kind of operations they are capable of performing. Ease of use for administrators is important since it can reduce the skill set requirements and thus the cost of administrators.
  - Provides user interface customization (not on the level of tiers of features, as above, but on an individual feature basis), so that both learners and administrators can optimize for their particular needs.
  - Is easy to install and reconfigure.

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  - Manages the administration process efficiently with built-in workflows (for approvals, for instance).
  - Administrative interfaces are clear, simple, and optimized for usability. Administrator interfaces are no less important than learner interfaces. Just because learner interfaces are well-designed does not mean the administrative interfaces will be also(!). This is particularly important where there is a need for non-technical staff to perform administrative functions (such as for instructors to pull reports and configure courses).
  - Includes options for remote administration from outside the enterprise intranet (through the Internet) and possibly via a handheld device.
  - Provides features that allow administrators to view role structures in a graphical representation (diagrams, outlines, etc.).
  - Provides clear, specific error messages that aid in troubleshooting. A generic message that is the same for all errors is not acceptable. You also want to avoid cryptic, technical messages that can only be interpreted by the LMS's software developers. Messages should be understandable not just to technically inclined LMS administrators, but also to content developer s. Also, it is ideal for error messages to vary depending on whether you are in the test vs. the production system.
  - Has a feature to store favorite locations within the system.
  - Allows saving of a workspace.
- **Ease of use for learners**
  - Displays interfaces that are consistent and standardized throughout all screens.
  - Uses straightforward, simple, and intuitive paths for performing administrator and learner job task functions. You should test your most common and important use cases on the system to verify this. See *3. Process for choosing an LMS*, step 11.
  - Has a feature to store favorite locations within the system.
- **Transcripts and other documentation**
  - Allows learners and administrators to print transcripts, course completion certificates, and student records with appropriate options.
  - Allows a learner to be able to view a transcript of all training that has been recorded in the LMS for their account along with status and status date.
- **Scalability**
  - Has a scalable architecture that allows the system to expand as the number of users increases. The following factors should be taken into account in your planning:
    - Number of concurrent users (current and in the foreseeable future)
    - Database licensing (by seat or site)
    - Database volume restrictions
  - Has a scalable architecture, enabling evolution of the client installation without forcing them to go through frequent major version upgrades.
  - Allows configuration of a data distribution network (interconnect distribution peers through a common distribution server)
- **Vendor characteristics**

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- Has a good reputation among acquisition and system owner communities. Ask the vendor who their other clients are, what they use the system for, and see if you can talk to these clients about their experience using the system. Look for negative comments posted on the Internet by members of these communities.
- Has been in the LMS market for at least 5 years. Avoid the first release of a new system.
- Has not created the product merely as an add-on to an ERP or some other system, in order to be able to sell it to customers desperate to add an LMS to their existing system. Although the cost will probably be lower than purchasing a separate LMS, and the system will obviously be well-integrated with the ERP, it can mean that the LMS receives short shrift in design and usability.
- Has a clear technology roadmap with a reasonable time frame for new versions and additions of new features.
- Has consulting experience and arrangements, especially with complex issues such as data migration
- Listens to your concerns during interactions with them, especially during demo sessions of their product. How they are in these situations probably reflects how responsive and attentive they will be to your concerns as a customer.
- Is financially sound and not in danger of going bankrupt. You may want to consider acquiring Dun and Bradstreet reports for your final vendor candidates, to establish the financial health, stability, and long term business strategy of them.
- Is of a stable size, as measured by number of employees, annual revenue, capitalization, etc.
- Has a robust ongoing budget for R&D.
- Has a large number of successful clients. Who the clients are and their industry stature can be important, especially in terms of their similarity to your mission or infrastructure. If you can, find out the number of total users served by the LMS product within this client base.
- Is not about to be acquired or merged with another vendor. Obsolescence and durability is an important consideration in the fast-changing landscape of LMSs and enterprise systems in general. You don't want a vendor that gets bought out by another company, and your LMS, with all of your expensive customizations, no longer functions because it has been reengineered to conform to the acquiring vendor's architecture, or worse, has been withdrawn from the marketplace because it is redundant with a product that the acquiring vendor already has in place.
- Has worked with many content developers using a variety of different kinds of content. Ask for references at organizations that have implemented content similar to yours.
- Is International Standards Organization (ISO) and/or Capability Maturity Model Integration (CMMI) certified to ensure high-quality software development output.

- **User training, support, and documentation**
  - Has robust support for training of all categories of users: students, system administrators, content managers, etc.
  - Has robust support documentation in a wide variety of forms including tutorials, help, examples, references, and user manuals.

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- Has a variety of Help Desk support options for administrators and learners (telephone, chat, email, etc.). These need to be in synch with the way your organization normally requests help.
- Has a Help Desk system that is structured and process driven via trouble call tracking and reporting.
- Has Help Desk support that coordinates problem resolution with the appropriate parties: vendors, SME's, etc. for problem resolution.
- Has knowledgeable, experienced support personnel.
- Is available as close to 24/7 and world-wide as possible.
- Offers extensive training options: e-learning, video tutorials, ILT sessions, webinars, etc.
- Has onsite training options. If training is at vendor site, the location(s) are a reasonable distance.
- Includes an orientation tutorial for new users.
- Has a low average turn-around time for Help Desk support.
- Has a feedback function for suggestions on improving the LMS.
- Provides technical consulting services options for customizations, implementation, configuration, architecture design, needs analysis, change management services, etc.

- **Media and content support**
  - Provides support for industry-standard streaming protocols for audio and video.
  - Supports immersive learning content. See *7.1 Support and optimization for immersive learning technologies* for more details.
  - (for VLEs) Provides the ability to push screen shots of the facilitator's screen to participants.
  - Supports a wide variety of media (see below) and media file formats. Examples include:
    - Audio
      - MP3
      - RealAudio
      - WAV
    - Video
      - MPEG-4
      - RealVideo
      - Quicktime
      - AVI
    - Documents
      - Microsoft Office
      - Adobe PDF
    - Graphics
      - JPEG
      - PNG
      - GIF
    - 2D animation
      - SWF
      - HLA Simulations

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- 3D animation
  - SWF

6.1 Popularity of features and capabilities

The *Elearning!* Magazine Group (DiDonato (2011a) p.36 conducted a survey across government and corporate enterprise learning audiences, which resulted in a list of the most popular "must-have features" among those planning to add, change, or replace their current LMS, as follows:

Course tracking/completions 90%
Testing & assessment 73%
Integrated reporting 70%
Course marketing/e-mail 53%
Authoring.....50%
Skills gap analysis 46%
Performance management 46%
Rapid development.....44%
On-demand option 43%
Career development planning.....42%
Applicant tracking 38%
Social networking tools 31%
Succession planning 31%
Compensation management.....16%

The Brandon Hall Group (2012) ranked core LMS features in order of popularity, according to a survey they conducted in 2011 (n=207), as follows:

E-learning courseware launching and tracking 1
Virtual class management, launching, and tracking 2
"Brick and mortar" classroom management.....3
Ability to define learning paths 4
Course catalogs and schedules.....5
Self-service course registration.....6
Built-in testing capabilities 7
Built-in surveys and quizzing 8
Customized/ad-hoc reports 9
Standard/predefined reports.....10
Course completion certificates.....11
Graphical reports/dashboard.....12

The Brandon Hall Group (2012) also ranked learning platform capabilities in the same survey, with results as follows:

Cloud-based installation 1
SCORM/AICC.....2
Customizable interface/branding 3
Customizable user profiles.....4
Multi-language support.....5
Customizable security levels 6
Integration with external authoring tools.....7

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Built-in authoring tool 8
Integration with HR systems.....9
On-premise installation.....10
Built-in LCMS 11
Built-in virtual classroom tool 12
LCMS integration capabilities.....13
Built-in e-commerce support 14
Off-the-shelf content included.....15

7. Emerging trends in LMSs

7.1 Support and optimization for immersive learning technologies

There is growing interest in game-based learning, intelligent tutoring systems, and virtual worlds. LMSs are now starting to catch up to support these technologies. Most commonly, users want to access the functionality of LMSs and virtual worlds in one tool, so virtual world vendors are also trying to add LMS capabilities into their systems. Virtual worlds integrate LMS functionality in a variety of ways.

The simplest way is for the virtual world to offer web browser capability, either inside of the world itself or through a daughter window of the application. The learner can then log in to their LMS and take e-learning courses while in the virtual world platform.

Another way is for instructors to create assessments or performance-based assessment nodes in the virtual world. Learners complete these and, either manually or through an automated script, connect to the LMS (or, at least, the tracking database portion of it) and communicate tracking data. The LMS in this case does not deliver any of the learning; it only provides the performance tracking capability. Usually this requires extensive middleware, though some virtual world vendors are working to include connectivity to selected LMSs.

The above cases start with a user who is operating within the virtual world platform, who then makes the connection to the LMS. The other way around is also possible, but much less common because it is technically more difficult: launching a virtual world as a learning object from within an LMS. A proof of concept called Sloodle is an example of this. Sloodle integrates the Moodle LMS and the Second Life virtual world by packaging a learning exercise in Second Life into SCORM e-learning using Second Life scripts and Sloodle middleware.

One key stumbling block to the “virtual world learning object inside a LMS” scenario is the lack of standards for the middleware and files formats that are needed to be able to import a course containing virtual world-based learning objects into an LMS, and have them delivered through the LMS. There are attempts currently to be able to author virtual world learning objects outside of the virtual world platform software. This approach has the potential to be platform-independent.

The other stumbling block is simply the different paradigms of learning that each platform (virtual world vs. LMS) is optimized for. For instance, LMSs are designed to afford individual learning experiences, whereas virtual worlds are designed to afford shared learning experiences (potentially with high numbers of participants); LMSs are designed for linear learning paths, whereas virtual worlds are designed for non-linear learning paths (often determined by many performance parameters based on dynamic events in the virtual world). Finally, virtual worlds vary greatly in their implementations, from single-user structured games to massively multi-user open environments. This presents a challenge in defining a universal method for LMSs to integrate with these products.

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For ideas on what may be in store for LMSs and VWs, visit:

- http://www.brandonhall.com
- http://www.virtualworldsreview.com/
- http://www.sl-educationblog.org/
- http://www.educause.com

See *Appendix D. Examples of Virtual Worlds Used in the Federal Government that Feature LMS Integration* for examples of LMSs that integrate with virtual worlds.

7.2 Support and optimization for social media

Collaborative, informal learning is well supported by theory and research (Mayer, 2005), and is often cited as the means by which the vast majority of learning actually takes place. Users are now demanding social media features as part of the learning toolkit that the LMS provides. These functions can be provided either as applications within the LMS (in other words, created or provided by the LMS vendor), or linked to external public sites. As in the case of virtual worlds, LMSs incorporate social media functions in a variety of ways.

Social media tools support many informal learning approaches (such as coaching, mentoring, and online knowledge sharing), where learners develop and execute their own learning activities in collaboration with instructors and fellow students. Sources of information may not be traditional "authoritative" sources, but sources determined valuable by learners and their peers, and methods of finding them can be based on learner research efforts.

Social media applications include the following:

- Wikis (for example, Wikipedia®), often with peer rating of content
- Social networking (for example, Facebook®)
- Blogs (for example, Blogger®)
- Micro-blogs (for example, Twitter®)
- Social bookmarking (for example, Delicious®)
- Social news (for example, Digg®)
- Picture sharing (for example, Flickr®)
- Video sharing (for example, YouTube®)
- Communities of practice (CoPs) (for example, Ning®)
- Expert exchanges (for example, Experts-Exchange.com®)

Some vendors are building simple interfaces into social media functions and sites, with no explicit connection to other learning content in the LMS, or performance tracking. However, some vendors are creating explicit connections, whereby the LMS determines, based on performance on an assessment in the LMS, that a learner would benefit from interacting with a community of practice (CoP), members of which might be available to mentor them. There can also be automated features where the LMS would assign subscriptions to social media functions to the learner.

LMSs are starting to emerge (for instance UdutuTeach®) that actually run on social media sites like Facebook, allowing a high degree of integration of LMS and social media functions, representing a movement towards turning social media sites into self-contained learning environments.

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Possibly the most important feature from the point of view of training stakeholders is the ability of an LMS to create and maintain CoPs for those interested in follow up activities to the course, or who are interested in the subject matter. Databases of contactable subject matter experts (sometimes called expert exchanges or expert locators) are important also.

The advantage of adding social media to an LMS is simply that it can provide a single access point for all learning experiences, whether centrally managed and formal, or self-managed and informal. This mix of structured vs unstructured learning is quickly gaining acceptance in enterprise learning, and LMSs are stepping up to the plate to accommodate it. No longer are learning experiences defined by a curriculum of structured courses predefined in the LMS course catalog; learners are expected to collaborate and share knowledge through tools and access points provided by the LMS. This sharing of knowledge can be through informal messages posted in blogs, forums, etc., but it can also be through upload of user-generated content such as slides and videos.

Social media as a general learning trend can be seen as a threat to the paradigm of centralization of learning and performance management that LMSs are currently predicated on, with the value placed on authoritative content source and control. However, many LMS vendors are embracing this technology and finding ways to maintain authoritative content source and control over learning despite its seeming pull in the other direction.

Despite the fact that LMS vendors are quickly getting better at integrating social media applications into the delivery of learning (whether maintaining authoritative control over the content source or not), they face a serious challenge in terms of tracking the learning progress of students within the social media application context. This has led to dire predictions of the demise of LMSs, due to their no longer being able to provide centralized monitoring and reporting of learner progress, one of the core business cases of owning an LMS.

A fundamental problem here is the fact that many social media tools do not in themselves contain any mechanisms for tracking learning; there is no function for an LMS to connect with (in terms of an API) to communicate anything resembling learning progress. Indeed, it would be difficult to define and quantify learning experiences that happen through use of many of these tools. But users are using them for learning (in many cases, in ad hoc, home-grown ways) nevertheless.

As self-directed, crowdsourcing-based learning through popular social media tools proliferates among users, organizations will have to embrace this highly decentralized array of tools as legitimate venues for learning. But, as mentioned above, these tools are not designed to interoperate with LMSs, and have no inherent drivers to achieve such interoperability.

One of the most important advantages of use of social media in training is that the learner group itself can usually provide a bigger pool of ideas for learning support and scaffolding than the instructional designer can come up with on their own. Scaffolding explanations, visual aids, etc. designed into the course by the instructional designer may work well for the majority of learners. However, allowing learners to see how some of their peers understand and relate to the material (through public postings of some kind) may provide better scaffolding for the statistical outliers who need scaffolding that only other outlier learners who think or learn the same way can think of. These learner postings can also be important where there is insider knowledge or attitudes in the organization or learner demographic group that the instructional designer is not privy to or does not understand completely, and learners can publicly process the material from that insider perspective.

One way that this learner-generated scaffolding principle can be implemented is an internal feature in the LMS whereby learners can take notes and make comments as they are going through the material. These notes and comments can be persistently stored between sessions and automatically associated with locations in the content. With the multitude of APIs to external social media applications that are now

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available, this can be implemented such that the notes and comments are posted publicly outside of the LMS, to applications like Twitter and Facebook.

One of the drivers for use of social-media in training is project-based, or experiential training. This is typically used in soft skill learning domains such as leadership, where a team of learners is given a project to accomplish and is evaluated on a rubric of parameters related to both process and product. The project may not be purely a learning exercise, but may actually be an attempt to solve an organizational problem. Social media is often leveraged in these cases to facilitate learners accessing the resources they need to complete the project.

In this type of learning, the LMS (mostly through social media applications) needs to able to push required resources out to learners at planned junctures in the learning experience, as well as enable learners to find and pull ad hoc resources as needed. In this way, the LMS becomes the "command and control" center for the learning experience.

For ideas on what may be in store for LMSs and social media, visit:

- http://www.sl-educationblog.org/
- http://www.brandonhall.com
- http://www.elearningguild.com
- http://www.astd.org
- http://www.gartner.com
- http://www.socialmediatoday.edu
- http://www.socialmedia.com

See *Appendix C. Examples of LMSs Used in the Federal Government and Social Media Integration* for examples of LMSs that incorporate social media.

Rather than acquire social media as functionality that is built into the LMS, there are social media software modules that can be integrated into LMSs. Examples include Learning Objects® (http://www.learningobjects.com/) and MediaWiki (open source - www.mediawiki.org).

One of the biggest problems that training stakeholders have with informal learning approaches based on social media tools is that there is no easy, straightforward way to assess and measure the impact of informal learning activities. LMSs that include competency models and 360-degree assessments are a good start, but a framework is needed to create and track progress towards actionable goals. Systems such as Talent Accelerator (http://www.envisia.com) includes goal evaluation tools to measure and evaluate learning gained from informal collaborative learning activities.

A recent emerging trend in social media-based courses are "massive open online courses" (MOOCs). These are courses where both participants and course materials are distributed across the Internet. They are usually based on informal learning principles, relying heavily on social media. Learners participate at the level of their time and interest, and there is no cost. Universities are usually the sponsors of MOOCs. Rather than author and deliver original content, you may be able to leverage content or curriculum components that are already offered in an MOOC. For more information on MOOCs, see http://en.wikipedia.org/wiki/Mooc.

If you use an informal social media-based learning paradigm that "mashes up" disparate sites and functions (using your LMS only as the initial Launchpad), you may want to consider a single sign-on (SSO) mechanism such as OpenID. This may be especially important if any cloud services outside of the LMS retrieve or post data. OpenID or some other open authentication mechanism can make interconnectivity in the cloud trusted.

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7.3 Open architectures

"Open architecture" infers that the LMS has APIs that allow integration of external applications and systems into the LMS, including, in some cases, swapping an LMS vendor-provided function with an externally produced one. Open architectures imply a relaxation of proprietary control and constraints on the part of the LMS vendor, allowing potential users to "look under the hood" at their implementation.

To enable open architecture, the vendor usually must share all or parts of its architecture with add-on/system integration developers. This may require some license agreements between entities sharing the architecture information.

In spite of the potential for competitive disadvantages resulting from publicly exposing the inner workings of their system, some vendors favor them because their customers want to be able to easily customize the system by purchasing additions that the LMS vendor may not feel are important enough to develop themselves.

Open architectures have driven the creation of a substantial marketplace for third-party applications that can be integrated into the core LMS system as modules. These modules can provide all sorts of functions ranging from anything like adding a calendar function to the learner interface (similar to widgets that you can add to a web portal or cell phone) to providing the capability to share data with an ERP system.

One trend that is making open architectures easier and less costly is the current movement from proprietary database back-ends or MySQL to the Open Database Alliance.

As stated in *5.6 Security considerations for LMSs*, it is important to find out what programming language and third party OEM components were used to build the product you are considering acquiring. There are innate security considerations for some programming languages, like PHP. Also, if you will need to customize the system, your programming staff need to have the skill sets for that programming language and have licensing access to modify any third party components.

7.4 Adding authoring capabilities

Many LMSs, in their search for new frontiers of functionality to add to their system to add value to customers, have turned to authoring and knowledge management additions. Authoring is a natural addition to many LMSs, since it moves an LMS closer to being an LCMS, accruing many of the advantages that an LCMS affords (except for a content repository) without losing the essential ingredients of an LMS (see *4.2 Learning Content Management Systems (LCMSs).*

7.5 Extended enterprise learning

As reported in Roche (2011), enterprises are expanding the learner audience served by their LMS to include partners, distributors, resellers, franchisees, and even customers, who may be part of the corporate "extranet". No longer is the LMS relegated to internal employee training. The learner base and the scope of learning functions are becoming much broader. Learning in this paradigm can include such things as product demos, sales training for retailers, customer surveys, customer support documentation, and more. In some cases, a charge is levied on extranet users. As an extended enterprise learning system, the LMS is becoming more like the enterprise portal, in some cases, becoming completely integrated with or taking over most of the role of the corporate intranet/extranet portal.

7.6 Instantiation for individual business units

Many LMSs are adding the ability of a single enterprise LMS to create a customized interface and some degree of local control of administrative functions for different business units, divisions, workgroups, etc. within the enterprise. This has the effect of allowing these groups to have their own interface look and

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feel, course catalogs, etc., giving the appearance that they have their own LMS. It also may allow them to customize the administration of their "storefront" to some degree. This instantiation is usually implemented via login profiles, such that when a user from a certain organization logs in, the interface, available courses, global functions, etc. are delivered as configured for that organization.

The driver for the popularity of this feature is mostly economic; it allows an enterprise (especially a large one, like the Federal government) to save money through sharing of the same system, rather than each unit, agency, etc. having to purchase a separate system. Some pricing models do not present much of an advantage to this arrangement, however; it only works where an organization is paying for a greater capacity than they are using (and there are other organizations in a position to fill that capacity up to the maximum).

7.7 Adding knowledge management architecture and capabilities

Knowledge management (KM) system features seem like they would be a useful addition to an LMS, but functionally it is not that simple, since LMSs deal with content and KM systems deal with information. However, some vendors are trying to bridge this gap.

An LCMS is a better starting point for integration into a KM system, since that allows you to create small knowledge objects that can be combined into training content, and training content that can be repurposed as knowledge objects.

Knowledge management implies robust search capabilities; in this sense, any LMS that provides text search of training content is half of the way there to a KM platform.

7.8 Support for team-based learning

"Team-based learning" can mean nothing more than a group of learners in a meeting room taking a course together under one login, presenting themselves to the LMS as if they are one learner and making group decisions about how to complete course activities. It can also mean a group synchronously progressing through a course from different locations and being scored by the average of their individual scores. However, true team-based learning revolves around the idea of learning activities that both affect other team members' activities and are affected in turn by the actions of others in their team, who may be using a different version or part of the course based on their individual role in the team.

Thus, LMS support for team-based learning involves more than just providing communication functions in the LMS in order to provide collaboration and peer review by multiple learners (see *7.2 Support and optimization for social media*). Complicated assessment and sequencing paradigms must be enabled, with intelligent agents or middleware automatically tracking and mediating the activities and performance of each team member, and reporting rollup progress to the LMS as well as an audit trail for how these scores were generated (based on individuals' performance).

The technological challenges in this type of learning are now being worked out, but there is no universally accepted solution, so no prominent LMS solutions to supporting it have appeared yet. But as soon as the team-based learning paradigm becomes an established part of the training and education space, LMSs will surely move to support it.

7.9 "Gadget"- based interface

Gadgets (aka "widgets", "portlets" or "applets") are functionalities that are presented as separate items on a page. They are used in many commercial e-mail "MyPage" interfaces, and in many enterprise portal interfaces. They make it possible to completely customize the user interface; gadgets can be turned off so

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they do not appear on the interface, and can be moved to any location on the page. They can be associated with a specific role so that users only see the ones that are relevant or permitted for their role.

Note: Some make a distinction between "widgets", which are generic code objects that can be inserted into any web page, like a hit counter, and "gadgets", which are proprietary and will only work within a particular vendor's system. Here, we are mostly talking about "gadgets".

This type of portal-like interface has gained traction with some LMS vendors, simply because users are more comfortable with this type of modern interface, and it allows a high degree of interface tailoring to suit their needs.

7.10 Adding talent management architecture and capabilities

Talent management systems (TMSs) are sometimes called Integrated Talent Management (ITM) systems. Talent management includes recruitment, performance management, compensation and benefits, succession, retention, career planning, skills gap analysis, career development, and mentoring/coaching administration. These systems mostly deal strictly with these functions and do not provide the day-to-day HR processing functions such as payroll. An *Elearning!* Magazine Group survey (Roche & Upton, 2012) reports that TMSs now penetrate into 22% of the market, up from 16% in 2011.

Talent is the most expensive resource to acquire and maintain in most organizations, so the ROI for TMSs is often attractive, and many enterprises are eager to adopt them. An *Elearning!* Magazine Group survey (DiDonato 2011c) reported that the three most popular features sought by those wanting to acquire a TMS are:

Skills gap analysis.....59%
Mentoring/coaching administration.....50%
Career development.....50%

The terms "human capital management" and "workforce productivity" are also used synonymously with talent management. They overlap with LMSs in terms of the broad scope of their human resource development mission. However, whereas LMSs focus on training of current employees as a solution to a strategic enterprise talent or competency need, talent management systems focus more on recruitment as a solution. Talent management systems are often integrated with applicant tracking systems (ATSs) to manage the recruitment process, and can include performance management, compensation and benefits, succession, retention, and career planning.

Talent management integration or functional merging with LMSs is seen by many HR stakeholders as strategically important to HR functional integration, and for this reason, some LMS vendors are reengineering their LMSs so that they encompass both talent management and learning. This can result in automation efficiencies whereby competencies are assessed and result in recruitment and succession management actions. Career development is of course only one piece of the Human Resource Development (HRD) picture; managers must know who needs to be trained and certified based on what organizational deficiencies exist, and input these deficiencies directly into the process of acquiring new talent, if that is necessary based on the existing pool of talent.

For more information on LMS/TMS integrated systems, see http://elmezine.epubxp.com/i/74275 (Roche & Upton, 2012, p. 20-23).

7.11 Adding competency analysis tools

Some LMS vendors have demonstrated embedded or stand alone competency management or "precision skilling tools" which allow a user to self-assess their competencies in a specific skill area. The most common skill areas where this is being applied are information technology (IT), Microsoft Office applications, and, soft skill areas ("leadership skills" or "financial skills"). In lieu of laying out every

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competency inherent for a particular job or job category, these tools allow a user to analyze them independently and choose courses appropriate to their position, rank, rate, grade, specialty, etc.

Other LMS tools (sometimes called "skill management systems" (SMSs)) are becoming available to training and HR administrators to automate the labor-intensive tasks of manually matching training interventions (courses, units, lessons, topics, OJT, tests, career experiences, etc.) to the organization's job competency requirements (skills, tasks, knowledge, behaviors, etc.). The competency management process usually includes the following, which is becoming more and more integral to LMSs:

1. Determine competencies required for jobs
2. Profile competencies and their current levels throughout the organization
3. Determine the gap between existing and desired competencies
4. Define objectives and other descriptors of courses that are needed to close the gap
5. Match learner competency deficiencies to learning tracks, training programs, and courses
    - Define user groups based on competency requirements
    - Define courses and curricula based on competency requirements
    - Map competencies to courses or any other training intervention
    - Map students to courses or any other training intervention
    - Map students to continuum/advancement tracks
6. Plan learning track and training programs that incorporate these courses, in order to close the gap
7. Provide training recommendations (to include prerequisites) to fill competency gaps
8. Evaluate competencies after learning

7.12 Component-based architecture

In a component-based architecture, a vendor licenses a product for use as an on-demand service—customers pay for only the components they use. It presumes a modular architecture whereby the vendor compartmentalizes the system so that users only access (and pay for) the parts that they need at any given time. This method is attractive to many organizations because it can lower costs (since you only pay for the features you use), in contrast to licensing all applications/modules/functionality 24/7 throughout the life of the installation.

Certain aspects of the architecture of such a system must be designed specifically for component-based architecture by the vendor, so that features can be turned on or off, depending on the needs of individual customers. Many current systems offer some degree of component options; qualifying as "component-based" is only a matter of the degree to which the system and the pricing model is optimized for it.

Component-based architectures are usually associated with hosted solutions (see *5.7 Hosted solutions*). However, a hosted solution may be sold with or without any compartmentalization. For instance, a hosted solution may simply be a one-size-fits-all system based on a flat fee covering a specific number of licenses that cover using all parts of the system; a component-based architecture solution is usually hosted but in addition also involves a modular, compartmentalized approach, as described above.

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7.13 Multimedia LMS (MLMS)

LMSs are starting to appear that call themselves "multimedia LMSs." They base their value proposition on the ability to synchronize moving images with still images on two modular screens. One such example is Knoodle (www.knoodle.com). This system is essentially an integrated authoring tool and LMS, since the synchronization is authored in the MLMS (based on imported PowerPoint and video assets). A typical use case for this arrangement might be a talking head video of a senior manager introducing slides introducing a new corporate policy or structure that is shown on the adjacent modular screen.

The principle of a dual panel e-learning module, with video or animation in one panel, and static images in the other, is not new; VLEs can display content in this manner, and many authoring tools allow authoring of this format within the content itself. However, these MLMS products are optimized for this kind of delivery, with the ability of non-technical authors to rapidly and easily synch static images (often in the form of PowerPoint slides) to the video or animation. The content is tightly integrated with the standard LMS functions of learner tracking, tests, surveys, etc. This approach can work well if your organization decides that video synched with slides is the type of content you want to focus on, and you are willing to sacrifice interactivity, since the screens in this type of LMS are usually static. You will also need to have the internal resources to create and edit video.

7.14 Video conferencing integration

Recent developments such as greater levels of bandwidth, less expensive dedicated room-based videoconference equipment, and free personal videoconference capabilities on desktop computers have contributed to rapid growth in the use of synchronous videoconferencing in training and education.

There are three types of videoconferencing capabilities:

- **Personal** – designed to allow one user to see and talk to another user. These systems run on personal computers or smartphones, usually as a free peer-to-peer service. They usually are limited to one-to-one (between only two persons) communication, but are beginning to offer one-to-many capabilities (although quality usually degrades in such cases). Skype®, iChat®, and LiveMessenger®, and FaceTime® are examples of these systems.
- **Web-based –** these resemble the Personal category described above, except that the video appears in a browser and the service is managed through a central server. Because of the server-managed aspect, there is no loss of quality as more users are added to the conference. Examples are WebEx® and Elluminate Live®. Web-based videoconferencing is often a core feature of VLEs.
- **Room-based dedicated systems –** use dedicated hardware, often semi-permanently installed in meeting rooms. These proprietary systems usually include a codec (usually based on the H.323 standard), camera, microphone, large video monitor, and speaker system, and can be quite sophisticated (and expensive to use). Examples are Polycom®, Tandberg®, and LifeSize®.

Interoperability between these types of systems is increasing. For instance, some of the room-based dedicated systems offer software that allows personal computers (i.e., the "personal" category above) to connect to room-based conferences.

LMSs cannot generally technically integrate or host sessions in the "personal" and "room-based" categories, since these rely on external proprietary services, with particular software and hardware requirements. They can facilitate and coordinate videoconferencing sessions as learning activities within a course or curriculum, however. This allows instructional designers to incorporate synchronous videoconferencing (of any of the three categories described above) in their instructional design and mix

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them with asynchronous learning objects. Examples of use of videoconferencing in these cases might include:

- Lecture, discussion, and Q&A with SMEs and instructors
- Virtual field trips
- Real-time collaboration on assignments between classrooms, assignment working groups, and individual students, especially in different parts of the world

7.15 Search-based learning

Google has become the default, preferred source of learning for many workers. DiDonato (2011a) p. 37, says that "The LMS is quickly becoming a non-destination for learners looking for quick answers to do their job. A Delphi Group study said that 25 percent of a 'knowledge worker's' day is spent searching for information to do their job. In polls of IT organizations on their preferred educational source, more than 96 percent said Google."

What does this mean for LMSs? The LMS must be able to handle federated searches across applications and domains. Searches should include not only the LMS, but the Internet, content repositories, and databases of experts. Being able to store content in a way that is optimal for quick and easy "just-in-time" future retrieval is an important element of this function. This involves not only bookmarking sites, but extracting small chunks of content to be stored in a knowledge management application or database.

7.16 Content delivery networks (CDNs)

If you deliver high definition video content to a highly geographically dispersed audience, and find that the performance is weak and/or this service is consuming too much of your LMS server resources to maintain sufficient quality, you may want to consider a content delivery network (CDN). Akamai® and Limelight® are examples. These services have strategically placed local servers operating all over the globe that make delivery of high-bandwidth video content smoother to dispersed populations of end users. If you do not have enough video content to justify having a direct, expensive, long-term contract with a CDN provider, there are resellers such as Rackspace (a reseller of Akamai's CDN) that offer pay-as-you-go agreements. These resellers enable you to deliver just a few videos very cost efficiently.

7.17 Support for mobile learning

Some vendors provide mobile versions of their LMS environments. These systems have interfaces that are optimized for mobile devices and facilitate delivery of e-learning and documents in mobile formats. They are particularly useful for social media functions related to e-learning such as creating discussion threads and posts, creating content items, commenting on blogs and journals, etc.

There is some agreement among e-learning professionals that the mobile platform is not suitable for delivering standard e-learning, i.e., complete e-learning courses created for desktop delivery that have been reformatted for mobile delivery. This has mostly to do with the duration of courses; mobile users generally do not have the patience and an uninterrupted time frame (while not at their desk) to look at training information on small screens for long periods. Thus, mobile delivery is often cited as being most suitable for small chunks of learning (one rule is that each object should take no longer than 10 minutes) and learning-related functions such as:

- Tests
- Surveys

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- Just-in-time performance support, ranging from highly interactive coaches and decision support modules to static job aids
- Social media tools that provide access to experts, mentors, and communities of practice
- Drill exercises (e.g., electronic flash cards)
- Learning-optimized references (e.g. infobases)

Smartphones are particularly well-suited to location-based, contextual learning because of their built-in GPS capability. Games for learning can work on the mobile platform, but generally only if they are simplified. If you are acquiring an LMS for mobile learning, you will need to consider carefully what kinds of learning experiences will be delivered, based on what is really appropriate for the mobile platform (given the above examples).

The following are some examples of mobile learning LMSs:

- Blackboard Mobile®
  http://www.blackboard.com/Platforms/Mobile/Overview.aspx
- Certpoint VLS Mobile®
  http://www.certpointsystems.com/products-and-services/enterprise-learning-platform/mobile-learning.html
- CourseAvenue Enterprise Mobile Solution
  http://www.courseavenue.com/
- Guinti eXact®
  http://www.exact-learning.com/en/products/learn-exact-suite/exact-mobile-solution-for-mobile-learning
- OnPoint Digital CellCast®
  http://www.mlearning.com/
- Intuition Rubicon®
  http://www.intuition.com/Mobile/home.aspx
- Litmos LMS®
  http://www.litmos.com/mobile-learning
- Moodle Mobile®
  http://docs.moodle.org/en/Mobile_Moodle_FAQ
- Trivantis Coursemill®
  http://www.trivantis.com/coursemill-learning-mangement-system-features
- Upside Learning LMS®
  http://www.upsidelearning.com/mobile-learning-solutions.asp
- Xyleme Mobile Learning Solution®
  http://www.xyleme.com/solution/mobile-learning

7.18 LMS as web services – is the traditional LMS dead?

There have been pronouncements from some quarters of the training industry that "the LMS is dead." On the face of it, this seems like a gross exaggeration; Brandon Hall (2011) report that 92% of their survey participants do not agree that the LMS is dying. However, it is true that LMSs are slowly receding into the background, at least from the point of view of end-users. The idea of having to log in to a monolithic

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system (LMS) as a one-stop shop for all learning-related functions and content is disappearing. The learning delivery function and learning content objects are becoming more distributed and available across systems, contexts, and devices. On-demand, granular performance support and learning objects are now embedded in a wide variety of application contexts. More and more, these learning objects can be launched anytime, anywhere. For instance:

- A link to scenario-based learning object within a corporate intranet page that announces a new policy (to train employees on how to handle situations that may come up regarding the policy)
- A link to a compliance training module in an email sent to a mobile phone reminding the user of an approaching deadline for taking this training (which can be taken on the mobile device)
- Screens in a new enterprise system that contain embedded tutorials and performance support

The LMS function needs to operate in the background to communicate with these learning objects and delivery functions and provide consolidated, meaningful measures of learning progress to stakeholders, while being invisible to the learner.

The first step that many organizations are taking is to provide the content delivery function as a service, separately from the LMS, using a browser plug-in or cloud-based application. This enables the "launch anywhere, anytime" paradigm for content. Many LMSs provide an offline player capability (see section *5.5 Offline player capability*) for disconnected use, but it seems inevitable that they will need to provide this for everyday connected use as well, given the growing "anytime, anywhere" paradigm.

SCORM Cloud® made by Rustici Software is an example of an "LMS in the background architecture". It allows you to generate "Dispatch" SCORM packages that you then import into your LMS. When students run the course from your LMS, it actually bounces them over to SCORM Cloud and plays the copy residing there. Your LMS does all of the tracking as it normally would.

A major challenge in this regard is tracking learner progress. If the content is no longer being launched from within the LMS, how can it find and communicate with the LMS? This problem is being addressed with APIs, standard data elements, and communication protocols, and will require industry agreements on standards. The ADL Co-lab has developed and makes available a number of solutions under the umbrella concept of "Next Generation SCORM". See http://www.adlnet.gov/capabilities/next-generation-scorm for descriptions of these solutions and downloadable software.

The role of an LMS in a use case involving an intelligent tutoring system is also currently unclear, although this seems that, given the appropriate back-end channels of communication, an LMS could at least provide value in terms of the tracking and reporting function.

Eduworks presents one possible way that LMS functionality may be disaggregated and presented as separate services (in slide presentation *Global Learning Summit: Present & Future of eLearning Infrastructure* (27 Feb 2009)). The disaggregated services would include the following components:

- Content Orchestration
- Assessment & Evaluation
- Directory Services
- HR Services
- Rights Management
- Search & Discovery
- Competency Management
- Results & Compliance Tracking

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- Social Networking
- Content Management

8. For more information about LMSs

- Bersin & Associates
  www.bersin.com
  This company sells a variety of resources and services related to e-learning, including buyers guides, comparative ratings, etc. to aid in the process of choosing an LMS.
- Brandon Hall
  http://www.brandon-hall.com
  This company sells a variety of resources and services related to e-learning, including buyers guides, comparative ratings, etc. to aid in the process of choosing an LMS.
- Edutools
  http://www.edutools.info/static.jsp?pj=4&page=HOME
  This community-driven site offers a variety of resources and services related to e-learning, including buyers guides, comparative ratings, etc. to aid in the process of choosing an LMS (though it mainly focuses on CrMSs).
- E-learning Guild
  http://www.elearningguild.com
  This professional membership-driven site offers a variety of resources and services related to e-learning, including buyers guides, comparative ratings, etc. to aid in the process of choosing an LMS.
- *E-learning!* magazine
  http://www.2elearning.com/
  This free magazine contains buyer's guides and articles that may be helpful for those involved in choosing an LMS.
- *Training Media Review*
  http://www.tmreview.com/ResearchReports/
  This membership-driven site offers a variety of resources and services related to e-learning, including buyers guides, comparative ratings, etc. to aid in the process of choosing an LMS.
- Rustici Software
  http://www.scorm.com/scorm-explained/scorm-resources/
  This site provides a publicly available SCORM-conformant LMS that can be used for testing and demonstration. It also has a variety of information pages including such topics as what to ask for in your LMS RFP to ensure SCORM is what you want, need, and expect (see http://www.scorm.com/scorm-explained/scorm-resources/what-to-ask-about-scorm-in-an-rfp/)
- E-learning Centre (UK)
  http://www.e-learningcentre.co.uk/eclipse/vendors/authoring.htm
  This site is sponsored by a non-profit e-learning consulting organization. It contains free information resources related to e-learning systems and tools, including reviews to aid in the process of choosing an LMS.
- *Directory of Learning Tools* (Centre for Learning and Performance Technologies)
  http://www.c4lpt.co.uk/Directory/Tools/authoring.html
  This site is sponsored by a non-profit e-learning consulting organization. It contains free

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information resources related to e-learning systems and tools, including reviews to aid in the process of choosing an LMS.

- *Vendors of Learning Management and E-learning Products*
  http://www.trimeritus.com/vendors.pdf
  This free report provided by Trimeritus Elearning Solutions, Inc. includes a lists of LMSs and other e-learning products.
- *DOD Instruction 1322.26, Development, Management, and Delivery of Distributed Learning, June 2006.*
  http://www.dtic.mil/whs/directives/corres/pdf/132226p.pdf
  This document describes DoD requirements for content and LMSs regarding SCORM conformance.
- *The Complete(?) list of Open Source Learning Management Systems* (Gilfus Education Group).
  http://www.gilfuseducationgroup.com/open-source-learning-management-systems-the-complete-list?goback=%2Egmp_2386016%2Egde_2386016_member_132664397
  This web site has an extensive list of open source LMSs primarily for use in higher education and K12 learning.

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Appendix

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A. Sample System Requirements Matrix

The following is a sample of a matrix that can be used in step 7 presented in section 3: *Process for choosing an LMS.* The step is described as:

Develop and populate a requirements matrix that allows assessing the systems identified in step 6 against your requirements developed in step 3.

To use the matrix:

1. Replace the top row with items you have determined to be your requirements for the system. For example, for "Standards compliance", you could substitute "SCORM 2004 3rd Edition, Section 508".
2. Put the list of systems in the "Product name" column.
3. Research and complete the cells with information indicating whether each system meets that requirement (may be "yes" or "no", a more lengthy description of how it meets or doesn't meet the requirement, or a number that roughly quantifies the degree to which that requirement is supported in the product).

LMS Requirements Matrix

	Media supported	**Inter-activity level**	**Administration skill set**	**Editing by non-technical staff**	**Output file formats**	**Standards comp-liance**	**Support and training req'd**	**Collab-orative authoring**	**Number, roles, and distri-bution of users**	**IT consider-ations**	**Budget**
Product name											

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B. Sample System Features Rating Matrix

The following is a sample of a matrix that can be used in step 10 presented in section 3: *Process for choosing an LMS.* The step is described as:

Develop a system features rating matrix (see the Appendix B: Sample System Features Rating Matrix for a sample) that compares the systems identified in step 8 using the features list developed in step 9. Complete as much of this matrix as possible from the systems' documentation; if you need more information, ask their sales representatives for it (though beware of overblown claims—verify lofty ones independently if possible). Assign a numerical rating for each cell in the matrix, indicating degree of implementation of that feature; "0" would indicate that a particular LMS does not have that feature, and "10" indicates that it has a very robust implementation of the feature. The matrix should weight each feature according to its importance to you, enabling a rollup score for each system.

To use the matrix:

1. Replace the top row (Feature1, Feature 2, etc.) with the names of all relevant features you have compiled for the systems.
2. For each Weighting factor cell in the row below it, replace the text with a number between 1-3 to weight the relative importance of that feature to your organization (the higher the number, the more important).
3. Put the list of systems in the "Product name" column, then research the feature information for each system and complete the cells with the number indicating the degree to which each system has that feature. We suggest 0-2, 0 being "does not have that feature" and 2 being "has implemented this feature to the fullest extent possible". You may want to use a rubric developed by Brandon-Hall (Brandon-Hall/Saba webinar "Selecting an LMS" 9/14/10) that rates the feature in terms of how "out of the box" it is. Assigning numbers to their rubric would yield the following rating scale:
   - 5=Automatic (built-in, out of the box feature)
   - 4=Semi-automatic (mostly built-in, but requires some programming or customization to activate)
   - 3=Semi-custom (partially available. The system can be adapted to implement this feature through moderate customization)
   - 2=Custom (not available but can be added, possibly at high cost, with programming)
   - 1=Not available (would be impossible or cost-prohibitive to customize the system to add the feature due to incompatibilities with system architecture, etc.)

   If a feature is not available, you may also want to note in this matrix whether a feature is available from another vendor as an add-on, so as not to totally rule out/penalize the vendor for lack of that feature. This can be incorporated into the rating scale such that a rating of "3" means that a feature is available as a third party add-on.
4. The rollup score column at the far right will provide the total weighted score for each system (right-click on it and select **Update Field** after you make any changes to the weighting values or ratings).

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5. If you add columns or rows, copy and paste the Rollup score formula and adjust the row and column references in the formula accordingly. Right-click the pasted Rollup score and select **Toggle Field Codes** to see and edit the formula.

LMS Features Rating Matrix

	Feature 1	**Feature 2**	**Feature 3**	**Feature 4**	**Feature 5**	**Feature 6**	**Feature 7**	**Feature 8**	**Feature 9**	**Feature 10**	**Rollup score**
Product name	*Weighting factor*	*Weighting factor*	*Weighting factor*	*Weighting factor*	*Weighting factor*	*Weighting factor*	*Weighting factor*	*Weighting factor*	*Weighting factor*	*Weighting factor*	
											0
											0
											0
											0
											0
											0

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C. Examples of LMSs Used in the Federal Government and Social Media Integration

The following is a list of five LMSs commonly used in the Federal government and their level of integration of social media.

LMS	Sample List of Integrated Social Media	Purpose of Social Media Integration	Challenges Perceived by Vendor to Adoption of Social Media
Meridian KSI	• Online communities • Blogs	• "Learning First" approach • Traditional LMS • Facilitate Communities of Practice	• Serious Use • Perceptions
OutStart	• Communities • Blogs • Wikis • MS Office • Email	• Informal Learning Enabled • Talent Management	• Lifecycle Management Issues • Tracking
Plateau	• Available through Virtual Learning System • Multimedia content • Application demos • VOIP • Real-time Collaboration technologies from Adobe Connect Pro, WebEx, LiveMeeting, & Centra	• Talent Management • Learning Management	• Integration • Timely accessibility to information
Saba	• Wiki • Communities of Practice • User-generated content capture and exchange • Discussion forums • RSS • Search-based learning • Real-time Collaborative capability (web-conferencing, e-meetings, & virtual classes)	• Learning Management • Talent Management	• Organizational Control (culture) • Quality/Accuracy

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LMS	Sample List of Integrated Social Media	Purpose of Social Media Integration	Challenges Perceived by Vendor to Adoption of Social Media
SumTotal	• Collaborative Web 2.0 Learning solutions • Online Communities • Discussion forums • Mobile access • Integration with SkillSoft, WebEx™, Interwise® and Centra® • Capture and categorize virtual events for use as job aids or information modules	• Learning Management • Talent Management	• Organizational Control (culture) • Quality/Accuracy

Sources:
http://www.usalearning.gov/USALearning/service_golearn.htm
http://www.brandon-hall.com

Chart developed as part of ADL presentation by Dr. Keysha Gamor

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D. Examples of Virtual Worlds Used in the Federal Government that Feature LMS Integration

The following is a list of five virtual worlds (VWs) commonly used in the Federal government that integrate with LMSs.

VW	VW Description	Purpose of VW	Challenges Perceived by Vendor to LMS Integration
ECS Nexus	• 3D environment • Avatar-based, interactive meeting environments • Massive Multi-User Online Environment (MMOE)	• Commercial collaboration & training • Government collaboration & training	• Tracking • Adoption • New Pedagogies
Forterra	• 3D environment • Avatar • Collaborative Meetings • Training & Learning • Events • Specialized Applications	• Commercial collaboration & training • Government collaboration & training • Higher Education collaboration & training	• Metrics • Integration
Protosphere	• 3D environment • Avatar • Secure Communication • Built-in Social Network	• Commercial collaboration & training • Government collaboration & training • Higher Education collaboration & training	• Integration • Tracking • Perceptions
OpenQwaq	• Scalable architecture • Secure, flexible, and extensible • Software as a Service (SaaS) • Qwaq Multi-Share • Built-in data encryption • Open standards	• Commercial collaboration & training • Government collaboration & training	• Learning Curve • Tracking • Integration

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VW	VW Description	Purpose of VW	Challenges Perceived by Vendor to LMS Integration
SecondLife (integration with Moodle is called "Sloodle")	• In-world commerce • APIs to customize desired capabilities/features • Service metrics • Open source	• Social collaboration • Multi-sector marketing, training & education	• Tracking • Security • Interoperability
Vastpark	• Not a single virtual world. Instead, it provides free software tools, APIs and open source libraries so you can deploy (and even monetize) your own virtual worlds and add-ons	• Commercial collaboration & training • Government collaboration & training • Higher Education collaboration & training	• Integration • Tracking

Sources: *Information gleaned from vendor web sites, conference presentations, workshops, and discussions.*

Chart developed as part of ADL presentation by Dr. Keysha Gamor

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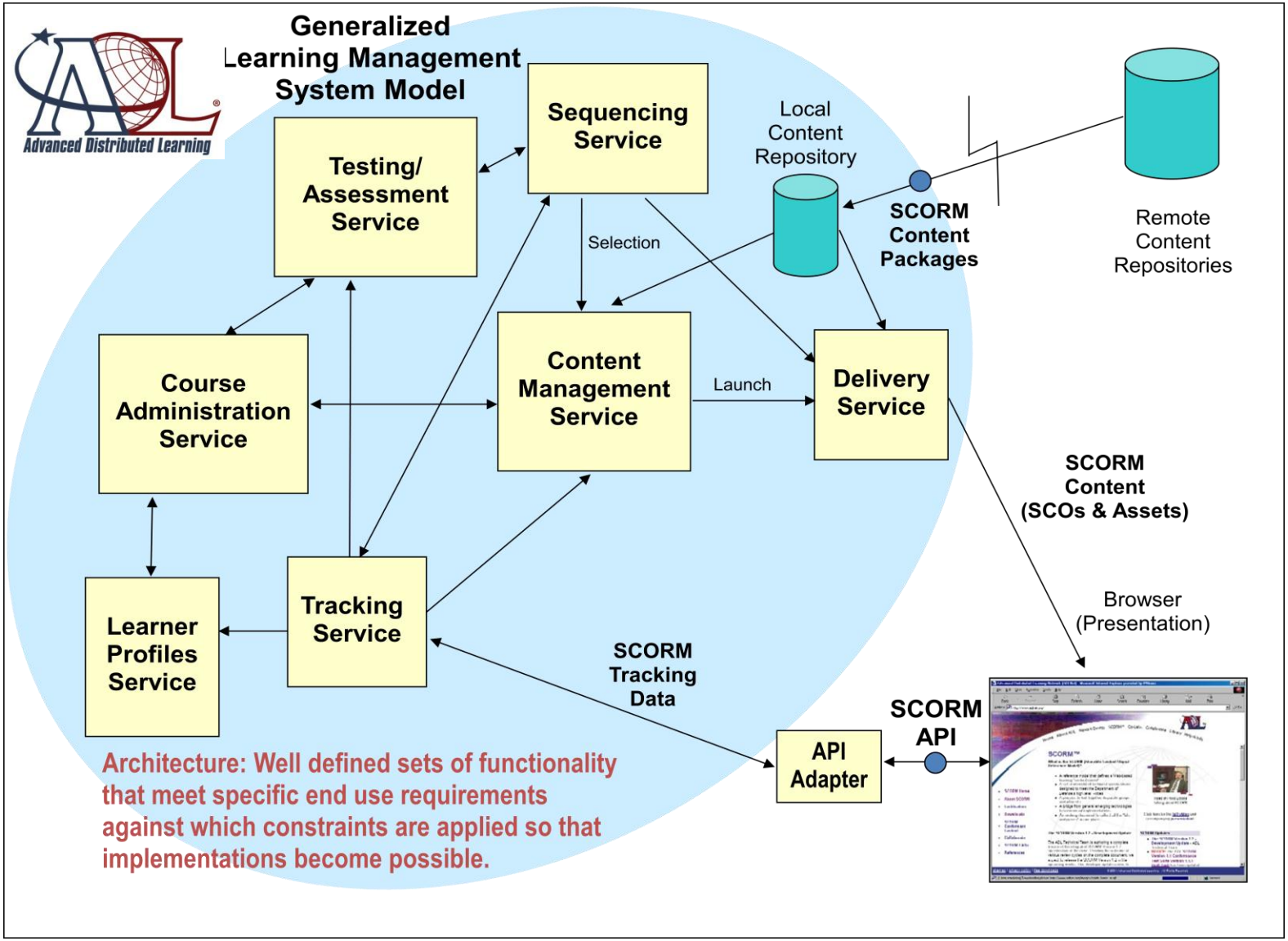
E. Diagram of Generalized LMS Architecture (including SCORM Elements)



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F. Security Considerations for DoD LMSs

The following are security considerations and requirements for any LMS that will be used within U.S. DoD. Many of these considerations apply in a more general sense to any military environment that is acquiring or installing an LMS.

- Unclassified system (NIPRNET)
- Classified system (SIPRNET)
- Certification requirements
- Customer databases
    - Defense Enrollment Eligibility
      http://usmilitary.about.com/library/milinfo/dodreg/bldodreg1341-2i.htm
    - Reporting System
      http://usmilitary.about.com/library/milinfo/dodreg/bldodreg1341-2i.htm
    - Army Knowledge Online
      http://www.army.mil/ako/
    - Navy Knowledge Online
      https://wwwa.nko.navy.mil/portal/home/
    - Navy Training Management Planning System
      http://www.ntmps.navy.mil/
    - Air Force Knowledge Now
      http://www.defensetechbriefs.com/
- Security Certification & Accreditation
  http://www.dtic.mil/whs/directives/corres/pdf/850001p.pdf
- Transport Layer Security (TLS)
  http://en.wikipedia.org/wiki/Transport_Layer_Security
- Public-Key Infrastructure (PKI)
  http://www.dartmouth.edu/~deploypki/overview.html
- Federal Information Processing Standard (FIPS – 140-1)
  http://www.cerberussystems.com/INFOSEC/stds/1401ig.htm
- Support for multiple levels of customizable security access
- Use of Mobile Code Technologies in DoD Information Systems
  http://www.dtic.mil/whs/directives/corres/pdf/855201p.pdf
- Security System Authorization Agreement – Required by DoDI 5200.40 - DoD Information Technology Security Certification and Accreditation Process (DITSCAP)
  http://en.wikipedia.org/wiki/System_Security_Authorization_Agreement

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G. Sources of Possible Requirements for U.S. DoD LMS Acquisitions and Installations

- DoD 5220-M-SUP - National Industrial Security Program Operating Manual Feb 2006 https://www.dss.mil/GW/ShowBinary/DSS/isp/odaa/documents/nispom2006-5220.pdf#page=75
- DoD Information Assurance Certification and Accreditation Process (DIACAP) Nov 2007 http://www.dtic.mil/whs/directives/corres/pdf/85101m_0700/p85101m.pdf
- NSTISSI No. 4009 - National Information Systems Security (INFOSEC) Glossary May 2003 http://staff.washington.edu/dittrich/center/4009.pdf
- OMB A130 Transmittal Number 4 - Management of Federal Information Resources Various http://www.whitehouse.gov/omb/circulars/a130/a130trans4.html
- Public Law 100-235 - Computer Security Act of 1987 Jan 8, 1988 http://www.nist.gov/cfo/legislation/Public%20Law%20100-235.pdf
- Subsection 552a of title 5, United States Code Jan 06, 2003 http://uscode.house.gov/uscode-cgi/fastweb.exe?getdoc+uscview+t05t08+27+0++()%20%20AND%20((5)%20ADJ%20USC)%3ACITE%20AND%20(USC%20w%2F10%20(552a))%3ACITE%20%20%20%20%20%20%20%20%20
- DODD 8500.1 Information Assurance April, 2007 http://www.niap-ccevs.org/policy/dod/850001p-E.pdf
- DoD 5200.1-R, “DoD Information Security Program Regulation,” January, 1997 http://www.dtic.mil/whs/directives/corres/pdf/520001r.pdf
- 44 U.S.C. § 3541, United States Code, "Federal Information Security Management Act of 2002" (FISMA)

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H. Update on the SCORM Certification Program for LMSs

As of this writing, ADL is planning changes to the certification process for LMSs. ADL decided that the process in the past was not rigorous enough. The process was made easier in order to foster adoption of the SCORM standard, but that caused problems. ADL did not restrict the certification designation to apply only to the particular version of the LMS software that was originally tested. Situations arose where upgrades and patches to the LMS software compromised the LMS code that supported SCORM. Thus, "SCORM certified" became meaningless for content developers whose SCORM conformant content no longer ran in the system, since certification actually only represented a point in the lifecycle of the software and never expired throughout changes to the system.

Under the new certification program, LMSs will be revalidated throughout the product life cycle. This is part of ADL's plan to make the certification process more robust, aligning it with the ISO standard for certification. Certified LMS vendors will be obligated to self-test their system after each dot release, sending the test log to ADL to prove that their SCORM module hasn't broken. For major releases, the vendors must recertify the system.

Other parts of the plan include:

- The ability for external entities to challenge the certification of an LMS, if content that is tested to be SCORM conformant does not run on a SCORM-certified LMS. The challenge process will force the vendor to demonstrate that the system is still compliant by submitting ADL SCORM Conformance Test Suite logs. If they are indeed compliant, ADL will upgrade the Test Suite and Sample Run Time Environment (SRTE) to account for the anomalous behavior in the content.
- A decertification process will be defined, in cases of egregious violations of the certification program terms and condition.
- ADL will issue guidelines on how the ADL logo can be used by certified entities.

In addition to these changes, ADL will institute an optional program to participate in the ADL Learning Technology Lab. Vendors can contribute their certified system to the lab to enable ADL to test and demonstrate their system, under the condition that they have to keep sending their updates to ADL. Benefits of participation in the Learning Technology Lab will include:

- Vendors don't have to provide logs to prove that they are maintaining certification through dot releases, custom installations, patches, etc. ADL will do this on the system in the Learning Technology Lab.
- ADL will provide the resources and logistical support to handle certification challenges (as described above)
- Vendors can occupy a space on ADL Learning Technology Lab portal, which has obvious marketing advantages.

I. Additional criteria for assessing quality and suitability of LCMSs

The following criteria are supplemental to the list of criteria presented in *6. Criteria for assessing quality and suitability of LMSs.* If you are acquiring an LCMS, you should add these criteria to that list. The criteria described here are relevant only to LCMSs, since LMSs do not normally include the content authoring and content repository features that are the hallmark of LCMSs.

If you are looking at an LCMS solution, it is important that you also focus on the quality criteria of content authoring features, in addition to the criteria found in this list and the list in *6. Criteria for*

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assessing quality and suitability of LMSs. For a list of quality criteria related to authoring capabilities, see ADL's *Choosing Authoring Tools* paper at http://www.adlnet.gov/capabilities/free-trial-demos#tab-learn (see paper listed under **White Papers** in **Resources** section). The list below does not include features that are related to content authoring, to avoid repetitive overlap with the *Choosing Authoring Tools* paper.

A high-quality LCMS, in addition to the criteria presented in *6. Criteria for assessing quality and suitability of LMSs*, will include the following features:

- **Navigation and administrative views**
  - Allows filtering of views so that you can view only a particular level of content in the hierarchy, or branch of the content tree.
  - Clearly shows where an object is being reused.
  - Allows filtering of views of content being developed, using metadata.
- **Content import**
  - Has mapping feature that allows you to indicate how the styles and items in Microsoft Office documents to be imported relate to the level of object in the LCMS. For example, an "H1" heading in a Microsoft Word document becomes a separate screen with that title.
  - Allows bulk media import (e.g., collection of media files within zip file) into content repository.
  - Imports containers that store external files, for example, a web site, with internal links between files maintained after import.
- **Creating ancillary content objects**
  - Easy to create ancillary course objects like bibliographies, glossaries, assessments.
  - For assessments, has an API that allows setting the values required to communicate scoring info between a simulation format like Flash and the LCMS.
- **Manipulating content objects**
  - Allows establishing objects at at least four levels of content object hierarchy (for example, course, module, learning object, topic).
  - Uses drag and drop as much as possible for moving objects within output structures.
  - Allows and has flexible options for orphan objects that are not assigned to parent objects.
  - Allows you to assign properties to multiple objects at once, without interfering with already existing settings.
  - Developers can lock container objects in a course even if there are child objects locked by other users.
  - Has flexible options for deleting content that is linked/ reused in other containers.
  - Has templates that can be applied at all levels of course structure.
  - Has robust prohibitions to maintain the integrity of relationships of objects. For example, it won't allow you to delete an object that is referenced by another object.
  - Allows overriding personalization settings for individual objects (that are subject to inheritance rules from parent objects)
  - Has features optimized for system training, such as built-in screen capture.

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- **Content preview**
  - Has viewers that emulate the way the content will look delivered for web, print, mobile device, 508 accessible e-learning, etc.
  - Allows viewing of content dynamically as it is created, with different viewers, themes, contexts, etc.
- **Repository storage, documentation, and management**
  - Has robust features for storage, documentation, and management of content versions.
  - Can restore easily to a previous version of an object.
  - Can export assets/media from the repository easily.
  - Contains a log for all system actions taken in the repository.
  - Allows audit of data movement in and out of the repository (e.g., "process viewer").
  - Allows partition administration. This is useful where multiple organizations share the same content repository.
  - Allows synchronization of data on different servers, if multiple servers are to be networked for different data sharing needs. For example, data on a development server could be automatically updated on production servers and review servers. This requires functions that identify the servers used and the content that will be delivered from one to the other.
  - Has a task broker that manages and distributes the load put on the server by tasks initiated in the repository.
  - Exports data from the repository into a packaged XML format. This means you can export data for the entire repository, not just for a particular object.
  - Allows caching of media contained in the database, eliminating the time needed to retrieve it from the repository when content is launched.
  - Supports PENS (Package Exchange Notification Services). With PENS, you can automatically export content to a PENS server as SCORM or AICC with notification.
- **Content delivery and output formats**
  - Can set up rules for whether an object displays to the learner or not (possibly by leveraging SCORM 2004 sequencing capability).
  - Has a slideshow feature for delivery of a series of raw images.
  - Is interoperable with PDFs such that a particular page can be opened vs always opening to the first page.
  - Has global search function for students that searches the entire repository or specified parts of it and allows grouping of search results.
  - Exports content to a variety of content formats, such as Word, PowerPoint, Framemaker.
  - Incorporates viewer objects that allow dynamic configuration of the way a learner will see delivered content.
  - Has an encrypted export option.
  - Allows export as compiled Help (.chm format) that has TOC and index.

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