

A Digital Rights Management Ecosystem Model For the Education Community

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1 The Digital Rights Management Challenge

In the education community learning content is created and managed in a complex and changing environment. Institutions and organizations are building digital repositories of learning objects and other content [25, 28, 30, 31]. These repositories are federating with each other and are providing widespread access in ways that make it difficult to know who or how their content and services are being used.

Nor are the processes of creating, delivering and using content simple or linear. Content goes through a life cycle during which multiple authors may be associated with any piece of content, and content may be distributed through multiple channels, modified several times, and used in many different ways for teaching and learning.

These developments require a careful examination of the requirements and methods for managing intellectual property rights using information and communication technology, in other words, for *Digital Rights Management* (DRM²).

Protection is not the only goal

DRM is often thought of as the ability to prevent consumers from accessing or distributing digital content without authorization³. This 'retail' view of DRM is based on a model where content is published by a single source and is ultimately consumed by users who do not modify the content.

Although commercial licensing is an important market mechanism that is used by for-profit publishers in education, it is not the only model of intellectual property management. Nor is protection against unauthorized use the only capability that must be supported by a digital rights management ecosystem. Educational and research activities require policies, standards and technologies that support the sharing and reuse of learning resources, rather than limiting that sharing and reuse [41]. Effective rights management is needed to *enable* sharing while respecting the conditions and requirements that rights holders have associated with their content. Digital Rights Management must act as an enabling technology, not just a controlling technology.

Rights management includes tracking and attribution

The goal of many content authors in academia is to share their intellectual property as widely as possible while receiving appropriate attribution whenever and wherever their works are used. In addition, many repositories and content providers want usage data, for evaluation purposes as well as for determining costs associated with distribution licenses.

Currently, attribution is enforced by professional norms within the academic community and usage is typically tracked and reported by distributors (such as bookstores) that have a direct relation with their content providers (such as publishers). This model does not meet all the requirements of distributed network environments.

² In this white paper DRM refers to the management of intellectual property rights using digital methods.

³ For example, the book publisher South-Western [50] defines DRM systems as those that "help protect the copyright of materials by defining how the content can be used. These rights are determined by the publishers."

Rights must persist in a distributed network

The IT infrastructures of universities provide access control and security within their organizational confines. These capabilities can be used to enable and control the use of documents and other files stored and used within these boundaries. However, content sharing in academia crosses the boundaries of technology environments and organizations to form highly distributed systems that can span the globe. Content may be distributed to any number of delivery media, platforms or environments.

Therefore, the technology used to express and enforce the terms and conditions associated with digital content must be 'persistent' in the sense that it must be available whenever and wherever the content is accessed, distributed or used.

Standards and models are needed

It is not feasible to use ad-hoc or proprietary methods for managing the intellectual property rights associated with so much content from so many sources. Standardized and automated methods are needed for expressing, transmitting, interpreting and enforcing rights. Similarly, a model is needed to assist organizations in analyzing their particular requirements and formulating or selecting policy and technology solutions.

The next section of this white paper puts forward such a model. It identifies the components and processes that make up a digital rights management ecosystem in the education community. The model is intended to provide a structured framework for analyzing DRM scenarios, requirements, roles and technology options. The output from the model is a structured analysis of DRM requirements, current and potential solutions, and the identification of gaps and issues in supporting these requirements.

In Section 3 the model is applied to specific scenarios representative of current reality in the academic community. The scenarios demonstrate how the model can be used to structure an analysis of digital rights management, identifying gaps and what is needed to fill those gaps. Section 4 addresses the process of preparing for automated DRM, walking through the components of the ecosystem model and pointing out some of the more important issues raised.

2 A Digital Rights Management Ecosystem⁴ Model

The DRM ecosystem model presented in this paper contains the following components:

A Rights Management Environment – Rights management takes place in an environment composed of the law, policy, practice, market mechanisms, organizations, roles, and expectations of the community. This environment sets the context, expectations and goals of any rights management implementation.

Actors – Rights apply to people and organizations, not to technology. Any implementation of rights management must identify the key actors and keep them firmly in mind. In our analysis, these are included as part of the environmental factors.

⁴ An ecosystem is "a system formed by the interaction of a community of organisms with their physical environment" [15]. The term is used in this paper to emphasize the need to look at the wider context in which an institution operates when examining DRM issues.

A Content Life Cycle – Digital rights management exists within the larger context of content management. Processes related to the creation, distribution, acquisition and use of content - the *content life cycle* – form the underlying structure of which DRM is part.

Tools and Applications – Content is created, distributed, acquired and used via software that includes authoring tools, content repositories, learning management environments and personal computing environments. Rights management affects all these tools and applications.

Rights Management Processes – The model organizes rights management processes into four major categories: Defining rights, distributing / acquiring rights, enforcing rights, and tracking usage. These are the processes that must be supported in a DRM ecosystem.

Standards and Services – Rights management makes use of services provided by an enterprise infrastructure and places its own demands for new standards and services. If the rights management environment provides the human context for DRM, then standards and services provide the technological context.

DRM Ecosystem Model for the Education Community

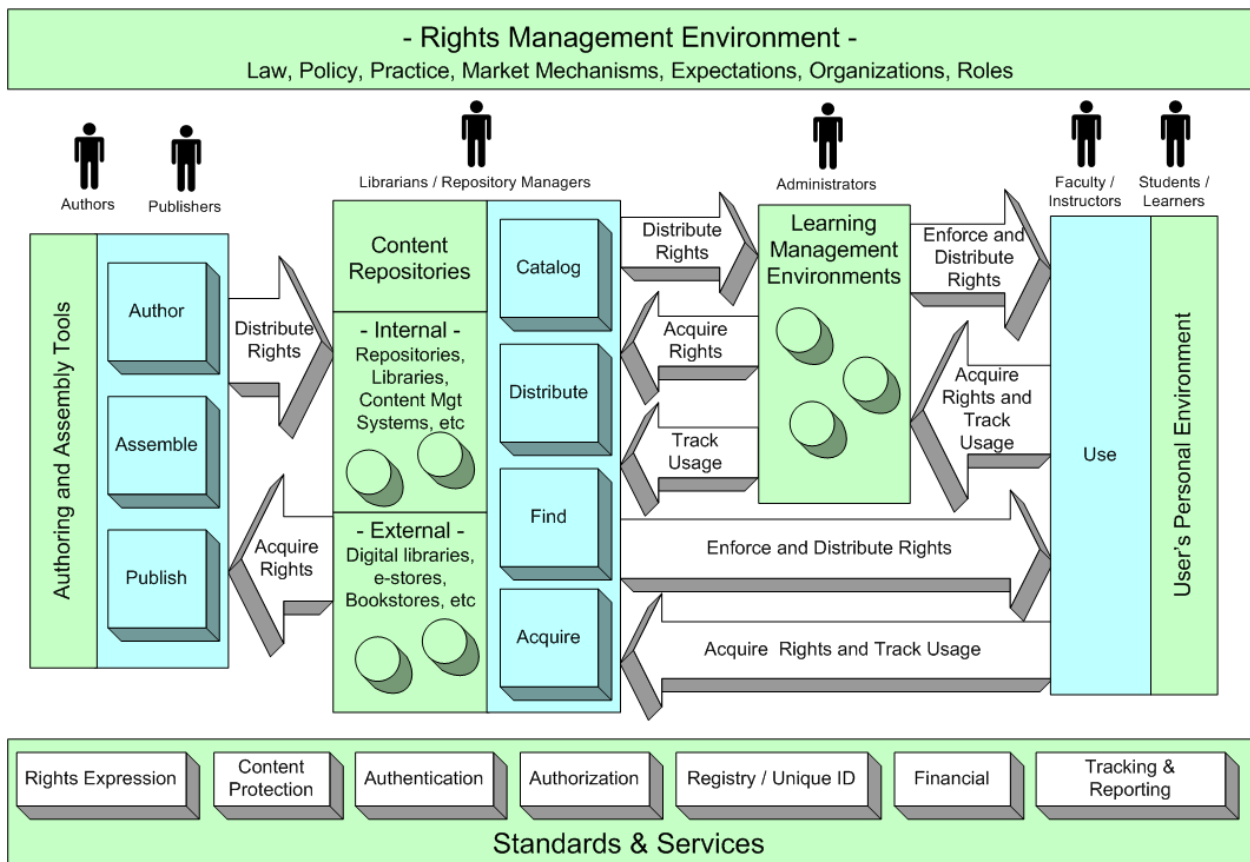


Figure 1

3 Applying the Model

The above diagram captures the components of this DRM Ecosystem model and shows how rights flow through the ecosystem. It depicts some of the specific actors, applications, standards and services that are relevant to the education community. Individual components will be discussed further in Section 4. In this section the model is used to analyze the rights management components of a given ecosystem. The steps involved are:

1. Identify environmental factors that affect rights management, including:
 - a. Market models
 - b. The legal and policy context
 - c. Important actors (organizations and people) and roles
 - d. Expectations for the management of rights
2. Identify the content lifecycle(s) in the scenario.
3. Identify where and how rights should be
 - a. Defined
 - b. Acquired and distributed
 - c. Enforced
4. Identify where and how usage should be tracked.
5. Identify what services are required for 3 & 4.
6. Identify what services are provided by existing technology.
7. Identify what functionality gaps need to be filled and what approaches are realistic.

This process will be illustrated using four scenarios.

3.1 Scenario 1 - Commercial Content

The first scenario is a straightforward one in which a college bookstore acquires online "course packs" from a textbook publisher. The course packs complement and support the textbook being used for a particular course. Course packs are loaded directly into a campus Course Management System through which students access them.

Analysis

1. Environmental Factors

- a. **Market models.** The market model in this scenario is a consumer model in which a rights holder (the publisher) distributes content (the course packs) to a consumer (the student) in exchange for money. The college bookstore is acting as a distributor that buys the content from the publisher and sells it to the consumer.
- b. **Legal and Policy Context.** As with all scenarios that will be examined, copyright and other applicable laws form the legal context. Depending on the country or

countries in which the transactions take place, different laws may apply. In countries with laws similar to the United States, the publisher is most likely the rights holder and is selling licenses that permit the content to be distributed and used in certain ways. This is no different than selling books, videos or DVD's. If some of the content is copy protected or prevents printing, then the Digital Millennium Copyright Act [51] may apply, making it illegal for students (or anyone else) to circumvent that protection.

c. Important actors (organizations and people) and roles. Important actors in this scenario include:

- The publisher of the course packs
- The college bookstore
- Faculty and instructors who assign the content
- Students who use the content

d. Expectations for the management of rights. The publisher expects contractual arrangements between it and the bookstore to be enforced and access to course packs to be restricted to students who have bought the text or the course pack supplement. The publisher may require that usage be tracked so that it knows how many units have been sold and the bookstore may want to track usage as part of its inventory control system. To protect its business model the publisher would also like the contents of course packs to be protected from unauthorized modification, replication or distribution.

2. Content Lifecycle

In this scenario the content (course packs) enters the college ecosystem from an external but controlled source (the publisher). It is distributed via a Course Management System and is "consumed" by the student. This is simple linear distribution chain in which no modification of content takes place.

3. Rights

a. Definition of Rights. In this scenario rights are defined through existing law and through a contract. This works because the publisher and the college bookstore are trusted partners who negotiate a contract directly with each other. The course packs are only made available only after a relationship is established and contracts are in place.

b. Acquisition and Distribution of Rights. Students acquire rights from the publisher by purchasing a textbook or by separately purchasing a license for the course pack. The college bookstore school acts as an intermediary who distributes the rights to the students and also acquires distribution rights from the publisher.

c. Enforcement. There are three places in this scenario where rights might be enforced.

- The publisher might rescind distribution rights if the bookstore does not meet required terms and conditions.
- The Course Management System could enforce rights by denying students access to the course pack if access is not authorized.

- The content in the course packs may include intrinsic protection that prevents it from being copied or altered. It might also be encrypted in a way that requires a student to enter a key before the content can be displayed.

4. Usage Tracking

If usage tracking is a requirement, then it will be tracked either by the Course Management System when the course packs are used or by the bookstore when the course pack licenses and textbooks are sold.

5. Services Required

The services potentially required in this scenario include:

- Content Protection (copy protection or encryption)
- Authentication and authorization services
- Financial services (to handle fees and licenses)
- Usage tracking and reporting services

6. Services Provided by Existing Technology

Course Management Systems provide authentication and authorization services. Sometimes these are integrated into larger institutional authentication services. If access is granted by course or by section, this type of authentication and authorization is sufficient.

Financial and usage tracking services associated with selling text books and course pack licenses are already in place and being used.

Copy protection requires "rights enabled" software. Some document formats (such as PDF) can be more easily copy protected than others. Copy protection can be "hacked," but the Digital Millennium Copyright Act makes this a federal offense in the United States.

7. Gaps / Future Technology

The rights management required by this scenario is not significantly different than that required for traditional sales of books or media. The sticky points are:

- Course Management Systems may not be able to conveniently handle access control based on anything more than membership in a particular class or section. Mechanisms are needed to provide access based on external factors such as the possession of a license.
- Copy protection depends on developing technologies that have not been fine-tuned. Ideally students should be able to legally and conveniently make *backup* copies of content accessed through Course Management Systems but prevented from distributing copies.
- There is no persistence of rights management once content is copied into the student's personal computing environment. The rights associated with the content are not expressed in a way that can be interpreted and enforced by personal computing technology from other vendors.

3.2 Scenario 2 – Sharing a Faculty-Developed Test Bank⁵

A professor has developed a bank of interactive test questions. Funding for the project was received from the National Science Foundation (NSF) and in return the professor promised to (a) make the question bank available to any faculty member at any accredited university or college and (b) report the usage of the test bank to the NSF.

The test bank can be downloaded in the form of an executable file. With some technical expertise, this file can be used to make questions available on a course Web site or used to load questions into a Course Management System. The professor makes the executable file available on her own Web site and also gives a copy to her university's library, where it become part of a searchable institutional repository.

Analysis

1. Environmental Factors

a. Market models. In this scenario, attribution and contributions to the community translate into funding, promotion and other personal rewards for the author. The rights holder does not expect the content to be sold. Should a commercial content provider wish to sell or distribute the test bank, a new market model would come into play.

b. Legal and Policy Context. Copyright [52] and other applicable laws form the legal basis for rights management. Although funding for the test bank came from the NSF, the NSF does not claim any intellectual property rights. Therefore the rights holder is either the professor or the professor's institution (or some combination), depending on the terms of the professor's employment. In practice, the professor is either the rights holder or acts as the prime agent for the rights holder.

Policies (or legislation) about privacy, record keeping etc. could affect rights management in this scenario. Despite the fact the professor wants to collect data on the usage and results of her test questions, this data may be confidential.

c. Important actors (organizations and people) and roles. Important actors in this scenario include:

- The professor
- Faculty and students at other institutions
- The library at the professor's institution
- The National Science Foundation

d. Expectations for the management of rights. The professor expects that attribution will be given whenever her questions are used and that usage data will be returned to her. The professor does not expect the content to be sold or commercially distributed, and does not wish the test bank questions to be modified without her permission.

⁵ This scenario was proposed by Gerd Kortemeyer as part of an interactive presentation on DRM at the NLII 2004 Annual Meeting, and was analyzed through a role playing process during that presentation. Gerd is the Director of the Michigan State University Laboratory for Instructional Technology in Education [24].

The professor also expects that faculty will assign questions and that students will use them. She does not want students to have access to her questions other than as part of a course.

2. Content Lifecycle.

The question bank was created by the professor in her own personal computing environment. She distributed it to her own Web site and to the university library. Faculty members download the associated executable file from her Web site or from her institution's repository. The file allows questions to be incorporated into class Web sites or loaded into a Course Management Systems. Students interact with the quizzes through these sources.

Some faculty members who use the questions want to make additions and changes. To do so they must contact the authoring professor for permission and to obtain the source code for modification.

3. Rights

- a. **Definition of Rights.** This is an example of a distributed use model where the partners are not known to each other in advance. Access to content (the interactive questions) is governed by roles (professor or student). Rights may be explicitly defined by statements incorporated into the content (e.g. a license agreement), by a statement on the professor's Web site or by a statement associated to the question banks in the library's institutional repository.
- b. **Acquisition and Distribution of Rights.** Faculty members acquire usage and distribution rights when they download the executable file for the question bank. Students acquire rights when they use questions through a course Web site or Course Management System. These rights must reflect the distribution rights originally granted by the authoring professor: faculty members do not have the right to modify the questions without permission and students do not have the right to access the executable file or (implicitly) to distribute and share questions.
- c. **Enforcement.** The ban on modification of the executable file is enforced by its format – without the source code it cannot be edited – but an authentication and authorization system is needed to prevent students from accessing the executable file. This system must be in place on the authoring professor's Web site and in her institution's repository. If a faculty member downloads the executable file, it becomes that person's responsibility to enforce distribution restrictions. Moreover, some type of copy/print protection is needed to prevent students from distributing copies of quiz questions. Those protections could be provided within the content (put there by the author) or enabled by the systems used to deliver the quiz questions, e.g. a Course Management System.

4. Usage Tracking

The authoring professor wants the usage of questions reported back to her. She may have to settle for download statistics from her Web site and from her institution's library repository, but she would prefer to receive data back from faculty members who deploy her questions. This requires tracking at the point of consumption, meaning when students use the quiz questions.

5. Service Required

The professor's Web site and her library repository require authentication and authorization services to restrict access to the full question set to faculty at accredited educational institutions. Course Web sites and course management systems require authentication and authorization to restrict access to students enrolled in the course and possibly as part of the effort to prevent unauthorized redistribution of the quiz questions. Copy and print protection is required as discussed above.

Regardless of how rights are enforced in this scenario, they need to be expressed so that faculty members understand the terms of use (e.g. that reporting usage data is a condition for using the questions). If copy protection is to be implemented by systems delivering the quiz questions, then those systems must know that the questions are to be copy protected. The service required is a *rights expression* service that expresses rights, terms and conditions in a standardized way.

6. Services Provided by Existing Technology

Authentication and authorization services are provided by library repository systems. Systems like Shibboleth can provide trusted authentication across cooperating institutions. Downloads and usage statistics can be tracked using existing logging and reporting technology, and files in certain formats can be intrinsically copy/print protected.

7. Gaps / Future Technology

If the authoring professor disseminates her work through a typical personal or departmental Web site, it is unlikely to provide the needed authentication services. Furthermore, there is nothing to prevent a faculty member from downloading the executable file and intentionally or unintentionally granting access to students. If formats such as HTML are used for the quiz questions, copy and print protection is not available.

These gaps illustrate the need for a rights management methodology that associates rights with content in a way that travels with the content as it is distributed and re-distributed. Systems that can read, interpret and act upon standard rights expressions may fill this need, as illustrated by projects like the Australian COLIS project [4,9].

3.3 Scenario 3 – Community College Use of Video Materials⁶

A Community College history instructor has purchased a set of videos of the PBS series "The Civil War" by Ken Burns and wishes to make a number of scenes available online so students in his class can view them while working on a term paper. The community college has a media server that is capable of streaming digitized extracts of this video to students.

⁶ This scenario comes from [40].

Analysis

1. Environmental Factors

- a. Market models.** The initial purchase by the professor follows a consumer model where PBS distributes content to the instructor in exchange for payment. The market model relevant to the class, however, is one where content is provided by an educational institution in exchange for tuition. Even though PBS has a public service component, there is a discontinuity in the market models under which the video was acquired and under which portions are distributed.
- b. Legal and Policy Context.** The scenario described is precisely the type of situation envisioned by the TEACH Act⁷. Prior to enactment of the TEACH Act, online distribution of “displays and performances” (as a video is called in legal terminology) was not allowed. The TEACH Act makes this possible, albeit with numerous restrictions and requirements. In this scenario the Act requires that:
- The community college have a copyright protection and rights management policy in place and that staff (including the history instructor) be made aware of the policy.
 - If *The Civil War* is available in digitized form, the community college must purchase it. Converting video to streaming media is allowed only if there is no alternative source of digitized content.
 - The digitized versions of the scenes from *The Civil War* must be maintained in a way that reasonably prevents their use by anyone other than intended recipients, and that prevents use for any longer than is necessary for the students to complete their class assignment.
 - A copyright notice must be displayed to students.
 - The content must be protected in a way that *technologically* prevents students from obtaining local copies that could be re-distributed or used past the time period needed for the class assignment.
- c. Important actors (organizations and people) and roles.**
- The content publisher (PBS)
 - The instructor
 - The organization on campus that manages the server where the content will be hosted and served
 - Students taking the history course
- d. Expectations for the management of rights.** PBS expects that its intellectual property will be used in accordance with U.S. law [52], including the TEACH act. The community college administration expects that faculty and staff will follow institutional policies with regard to intellectual property rights.

⁷Technology, Education And Copyright Harmonization Act [40,53].

2. Content Lifecycle

The *Civil War* video was produced by PBS and purchased by the instructor. If a digitized version is available, this digitized copy must be purchased by the community college. The video will then be loaded to the server by the community college's technical staff and viewed by the students who are enrolled in the history course.

3. Rights

- a. **Definition of Rights.** Rights are defined by PBS at the time the video is published and sold. However, U.S. Copyright law, in particular the TEACH Act, also grants certain usage and distribution rights with associated conditions.
- b. **Acquisition and Distribution of Rights.** The instructor acquired a license when buying the video. This license most likely does *not* permit public displays or re-broadcasting. However, the TEACH Act does permit the instructor to display portions of the video online for a class. Thus the right to use the video as envisioned may be viewed as having been acquired at the point of purchase as well.

Students acquire rights to see the portions of the video when they enroll in the class, and these rights are distributed by the community college. The rights distributed to the students are severely restricted and do not include the right to redistribute content or even to retain content past the end of the period during which they are authorized to see it.

- c. **Enforcement.** There are numerous points in this scenario where rights need to be enforced. The original license purchased by the instructor (as part of buying the video) undoubtedly forbids copying and redistribution. If any technological protection is used, as might be the case with some newer digital formats, the Digital Copyright Millennium Act makes it illegal to defeat (or "hack") the protection. Even without protection, the community college will be very reluctant to put a copy on its media server in violation of copyright law: the threat of litigation sufficiently outweighs the cost of compliance, which in this case may mean buying a digitized copy. Once the video (or portions of the video) are on the media server, the TEACH Act requires that access be restricted to students enrolled in a class that is using it and that it not be made available for any longer than necessary. These restrictions might be enforced by the media server or by a course management system (or class Web site) through which the video is accessed. Downloading, at least in a form that can be retained or distributed, must also be prevented. Without more sophisticated services that express and enforce licenses, the most plausible way to do that is to use a format that cannot be converted to a local copy.

4. Usage Tracking

The community college is not required by law to track usage, but they presumably may be called upon to demonstrate that content used under the TEACH Act is only accessible by enrolled students and cannot be downloaded. The community college may wish to track usage for other reasons, such as generating statistics for internal budgeting purposes and the instructor may wish to track usage to see how the video is being used.

5. Service Required

Authentication and authorization services are needed to restrict access to students who are legitimately enrolled in the history course. Content protection (copy protection and / or encryption) are needed to prevent unauthorized copying and use of the content. Usage tracking is desirable.

6. Services Provided by Existing Technology

Course Management Systems provide most of the authorization and authentication services needed in this scenario. To meet the TEACH act restrictions, the system must restrict access to enrolled students, and limit that access to the times when the content is needed for class purposes. Streaming media can prevent copies from being made. This technology is available today.

7. Gaps / Future Technology

The basic TEACH Act requirements can be met with existing technology. However, there are still gaps. For example, there is very little extant technology that allows a document to be copied but not distributed or that allows a document to be viewed only during a specific time period. Moreover, access to resources in Course Management Systems is generally set up by instructors, adding another administrative duty to people whose primary job is teaching.

As with the previous scenario, what is needed is a way of associating rights *directly with content* and relying on systems (such as Course Management Systems) to interpret and enforce these rights, rather than programming the rights into the systems via access control.

3.4 Scenario 4 - Rights Management for Catalog Records⁸

A digital library reviews and maintains catalog records of material for K-12 mathematics and science teaching. The materials come from a variety of sources including

- Individual authors or schools
- Commercial publishers
- Educational outreach programs sponsored by agencies such as NASA
- Educational programs produced by public and commercial television
- Catalog records from other educationally oriented digital libraries

The records maintained by the digital library point to original sources from the material; with rare exceptions the digital library does not “house” any content itself.

Teachers, students and school districts use the digital library to find professional development material for teachers and content for students. The content is used in both purely online and traditional classroom settings. The digital library provides an interface that permits users to find content based on keywords, subject classifications, grade levels, articulation with curriculum standards, technical requirements and many other

⁸ This scenario is a real-life scenario based on issues faced by the Eisenhower National Clearinghouse (www.enc.org). For an example of an ENC record, see <http://www.enc.org/resources/records/full/0,1240,025708,00.shtml>

characteristics. In addition, the digital library allows other digital libraries to “harvest” its catalog records, just as it harvests records from them.

The digital library employs professional catalogers to review all materials in the library, to create summary descriptions of the material, and to generate the information needed for searches. This information is called *metadata* and it constitutes valuable intellectual property that the digital library has generated through the application of their resources. If teachers, parents and students know that a review or classification came from this particular digital library, they can assume that it is authoritative and accurate.

The digital library faces two rights management challenges:

- The digital library would like users to be able to specify terms of use (such as “no fee”) when searching its catalog, and to see rights information in a standard structure and format when catalog records are found.
- The digital library would like to appropriately protect its *own* intellectual property (the metadata records) in order to maintain “branding” and prevent misuse or misrepresentation of the reviews and metadata it has created.

Analysis

1. Environmental Factors

- a. Market models.** The content cataloged in the digital library comes from a variety of sources – commercial, private, publicly funded and academic. These all use different market models, but the digital library is acting only as a means to find and evaluate resources. In the scenario as written, the business model (and therefore the market model) for the digital library itself is not specified, but in fact it is supported by a combination of federal funds, federal grants and contracts with state or multi-state educational agencies. The metadata records created by the digital library can be used by other digital libraries at no fee, provided that appropriate branding and attribution are retained when these records are re-used.
- b. Legal and Policy Context.** The policy of the digital library allows for content of all types to be cataloged in the library, regardless of the terms of use associated with that content. The digital library is also subject to reporting requirements and other policies that result from the method through which it is funded. These, together with overarching copyright and intellectual property rights laws, form the context in which the library must operate.
- c. Important actors (organizations and people) and roles.**
 - The digital library organization
 - Authors and publishers of cataloged content
 - Education administrators, teachers, parents and students who use the library
 - Other digital libraries that share metadata records
- d. Expectations for the management of rights.** The digital library expects that its users will be able to see and interpret the digital rights associated with the content it catalogs. The digital library does not expect to be involved in *enforcing* digital rights on behalf of others, but it does not wish to interfere with rights

enforcement. The library expects to receive proper attribution and branding when others use its own metadata records and would like to have as much data as possible on how they are being used.

2. Content Lifecycle

The digital library provides the “find” function in the content lifecycle and therefore plays an important role in distribution and acquisition of content. It is also involved in the authoring and production of content, but only for its own metadata records.

3. Rights

a. Definition of Rights.

- Rights for the content cataloged by the digital library are defined externally to the digital library. Primarily, they are defined when the content is authored or published. However, the digital library might catalog content from another digital library or from an online distributor of educational material. In that case rights might be defined (or expressed) by an organization that is one or two steps removed from the source of the content.
- Rights for the digital library’s catalog records are defined when they are created and stored in the library.

b. Acquisition and Distribution of Rights.

- The digital library would like to interpret and display rights information as part of its catalog records and would like to permit users to search for resources with specific rights attributes (e.g. that are cost-free). However, as with the content it catalogs, the digital library does not want to be involved in the actual acquisition or distribution of rights.
- The digital library would like to properly distribute (and control the distribution of) rights to its own catalog records. For example, it would like ensure that they can be widely used but that it receives attribution and usage data in exchange.

c. Enforcement.

- The digital library does not enforce rights for the resources it catalogs. However, those resources might have associated rights that affect the way in which the digital library can catalog them. For example the associated terms of use may forbid “deep linking.”⁹
- The digital library would like attribution and usage rights for its own intellectual property (its catalog records) to be enforced when they are accessed, either directly or through a different digital library that has “harvested” the records.

4. Usage Tracking

Usage tracking is desirable so the digital library can analyze and report on usage and impact as part of its justification for continued public funding.

⁹ See http://fairuse.stanford.edu/Copyright_and_Fair_Use_Overview/chapter6/6-c.html for a discussion.

5. Services Required

The digital library needs a service that will allow it and its users to display and interpret rights associated with content that comes through a variety of channels.

Another required service is one that permits the digital library to uniquely identify objects (to avoid duplication in its catalog) and that ensures that links are up-to-date and function properly (so that users can access the content described in catalog). These services are often combined and called "persistent unique identifiers."

The digital library also desires a usage tracking service that will return data even when its catalog records have been accessed through a source that is several steps removed. For example, a catalog record from the digital library in the scenario might be harvested by a second digital library that maintains a catalog of educational mathematical resources. A school district might then find the record through this second digital library and place it in a resource section of its Web site. When a teacher uses the district's version of the catalog to retrieve content for classroom use, the desired tracking service would report this back to the digital library that originally created the record.

6. Services Provided by Existing Technology

In practice, the services do not exist today to support DRM in the distributed digital library ecosystem described above.

7. Gaps / Future Technology

Standards and technology are emerging for persistent unique identifiers based on registries and handle systems [11,19,20, and 32] and for rights expressions that can be read by humans and processed automatically by computers [21, 33, 54]. Persistent unique identifiers are needed for tracking and reporting and standardized rights expressions are needed to manage rights across distributed and federated networks of information sources.

4 Implementing DRM in an Ecosystem

As has been illustrated, the ecosystem model presented in Figure 1 can be used to analyze how rights are managed and what gaps need to be filled in particular scenarios. This section walks through the components of the Ecosystem one at a time, pointing out where policies need to be set and what technology should be considered in contemplation of implementing rights management in a real-world ecosystem.

4.1 The Rights Management Environment

A DRM ecosystem for education operates within a particular set of environmental conditions, composed of the law, policy, practice, market mechanisms, organizations, people with roles, and expectations of the education community. Recognizing and understanding these is the first step in a successful DRM implementation.

Actors (People and Organizations)

DRM, often equated with content protection, has a reputation as serving the publishers and vendors of content. In fact, it can and should serve a more diverse audience and it is of paramount importance to identify the real customer(s) in any DRM implementation. This can be complex and can lead to conflicting goals and measures of success, but it is necessary to acknowledge and face this complexity.

Law

Copyright law grants creators of an original work certain rights to their creations. These laws, which vary from country to country, establish the legal requirements and boundaries within which the education community must operate. Laws can both support and inhibit the management of intellectual property, but they cannot be ignored.

Market and Intellectual Property Management Models

Before a community can implement a rights management ecosystem, it must identify and agree upon the underlying market and intellectual property management models that will be in play. Market models might include retail and wholesale models, public funding models, free distributions models, and federations and cartels. Property management models might include centralized and decentralized control and client / server, distributed networks, and peer-to-peer networks. Each model and management approach has commensurate rights management and tracking requirements.

Rights and Conditions

Before selecting technology and services, a community must consider which specific rights, permissions and conditions will be supported by an automated ecosystem. Examples of specific rights are the right to: copy; print; modify; distribute; and use for commercial purposes.

The community must also agree on the conditions that can be imposed and enforced by the ecosystem in order to access these rights. Conditions can include things such as: payment required; limitations on the number of times a work can be copied, read, printed or redistributed; limitations on the time frame during which the rights can be exercised; and specifying the attribution required if the work is quoted or re-used in any way.

Choosing the Right Problems to Solve

DRM will be of the most value in an environment where there are simple, small and frequent transactions involving the use or exchange of intellectual property. If the transactions are infrequent then automation is not cost effective. If the transactions are overly complex, then automation may not be feasible. If the transactions are more suitably handled via traditional negotiations and contracts, then automation is not called for. Not all types of rights transactions are appropriate for automation.

As pointed out in the scenarios in the previous section, technology-based DRM is needed but the technology is in a nascent state. An approach based on identifying one or two key problems and trying to solve them with the best technology available is more likely to succeed than either doing nothing while waiting for the technology to mature or implementing everything in an attempt to solve all problems at once.

4.2 Content Life Cycle

Digital rights management occurs in the larger context of content management. In making decisions concerning rights management, it is important to determine how content is managed and, in particular, which aspects of content management are relevant.

The following is a basic model of content management that can be used for this purpose. More complete models of content life cycles and content management may be found in the books and articles referenced at the end of this white paper. [3, 7, 9, 23, 44, 45]

Content Life Cycle and Rights Issues		
Create		
Author	Create new content, from scratch or by modifying existing material	Rights are defined when content is created. Licensing policies and supporting technology should be considered.
Assemble	Bring together works from one or more sources and assemble them into a coherent learning module.	
Offer		
Publish	Prepare and issue content for public (or institutional) distribution.	Rights should be published, cataloged and distributed together with content. This may require preservation and expression of rights data.
Catalog	Classify and record attributes of content.	
Distribute	Distribute content to the targeted users.	
Acquire		
Find	Search for content and discover content that meets the search criteria.	Rights information can be used as a search criterion and rights must be acquired before content can be used.
Acquire	Acquire access to the content in the format needed to support the desired use.	
Use		
Use	Display, interact with and otherwise use content	Rights determine whether and how content may be used. Rights may be <i>enforced</i> when content is used.

Figure 2

4.3 Tools and Applications Supporting the Content Life Cycle

The content life cycle is supported by software that falls into several product categories. Rights management capability must be built into or work in concert with this software if rights management is to be automated. It is therefore important for decision makers to understand the various product categories and what the software provides¹⁰. This section provides an overview of these tools.

¹⁰ Brandon-Hall publishes regular reports comparing features and functionality of products in various categories. The executive summaries (usually available for free from [1]) provide definitions and explanations of various e-Learning product categories. [5] and [26] also contains information of this type.

Authoring and Assembly Tools

Authoring tools are used to create and modify content. They include general purpose content authoring tools (such as Microsoft's Word and PowerPoint, and Macromedia's Authorware, Dreamweaver and Flash), tools designed specifically for authoring learning content (e.g. Trivantis Lectora, Toolbook, and ReadyGo), and tools for authoring online tests (such as QuestionMark Perception).

Assembly tools are used to aggregate multiple pieces of content into meaningful learning experiences with appropriate navigation paths between content objects. Content can be assembled using an authoring tool or within a learning content management system or a course management system.

Rights management begins in the authoring process. This is one place where rights and licenses can be assigned to content, e.g. by explicitly defining rights associated with a new or derived work. Authoring tools must also be able to interpret and potentially enforce rights, e.g. by preventing existing content from being copied or edited.

Content Repositories

The term "content repository" covers a wide range of systems and services that store, manage and give access to content and metadata. These include library systems, content management systems, learning content management systems, digital asset management systems, e-stores, and Web content management systems. Repositories can have built-in search technology or rely on public search engines such as Google.

As content moves from author to student, it often passes through one or more content repositories. If rights management is to be automated, the repositories must preserve, process and transmit information about rights. Cataloging tools must handle rights metadata, and interfaces to repositories may be called upon to enforce rights, for example through a system of authentication and authorization.

It is useful to draw a distinction between *internal* repositories maintained by an institution and *external* repositories from which content is brought into an ecosystem. If a repository is "behind the firewall"¹¹, a combination of password protection and access control (based on the role of a user within an institution) form a rights management framework that works for many existing purposes. When content is required to pass across the institutional boundary, either as content provided to others or as content obtained externally, then rights must be associated to content in a persistent way, as discussed in the earlier scenarios.

Learning Management Environments

Learning management environments are designed to organize and deliver structured learning and to track a student's progress towards learning goals.

Course Management Systems and Virtual Learning Environments are products that instructors use to assemble online courses with syllabi, reading materials, chat rooms, email lists, and tests. These products also maintain class lists and authenticate users.

¹¹ "Behind the firewall" means that it is only accessible to authorized users from within an institution's IT environment.

Learning Management Systems refer to products used to manage learner records and learning resources, usually in corporate or government training environments. They keep track of certifications, perform skill gap analyses, maintain a learning catalog, manage classroom resources, handle financial transactions and deliver content. In the academic space, the term “learning management system” is often used as a synonym for course management system or virtual learning environment.

Learning management environments both access and serve as content repositories. As pointed out in Scenario 3, the access control provided by course management systems suffices for many, but not all, rights management purposes. The challenges mount when they start interacting with external repositories.

Personal Computing Environments

Ultimately content is accessed through a personal computing environment on a workstation, desktop, notebook or tablet computer or on a hand-held device. This environment includes applications and functionality that enables content to be displayed, printed, copied, modified and shared with others. Rights management can involve both the system that is providing access to content (e.g. a Learning management environment) and the computing environment itself. Inasmuch as the traditional approach to DRM has been one of protecting content and enforcing this protection in the applications that could potentially print, copy, distribute or display the content, DRM has heretofore been largely viewed as being enacted in personal computing environments.

4.4 Rights Management Tools, Services and Standards

The DRM ecosystem model and the scenarios address four distinct aspects of rights management: defining rights, distributing / acquiring rights, enforcing rights and tracking usage. This section discusses some concepts, services and standards that are relevant to the automation of these processes.

Licenses

A license is a legal vehicle for granting an individual or organization an explicit collection of rights and conditions for the use or distribution of a copyrighted work. The expression or codification of the rights and conditions granted is also called a license.

It seems impractical to expect a real-world DRM ecosystem to deal with complete range of possible terms, conditions and licenses. It is therefore suggested that a community define a few standard licenses that meet their needs, as is done by the Creative Commons [8]. This suffices for most purposes and greatly simplifies implementation and adoption. Without licenses, users may not be able to modify content for reuse and may not even be able to use it all¹².

Usage and Distribution Licenses

Licenses can only be granted by the owner or rights holder of a copyrighted work, but this can occur directly or indirectly. Every time content changes hands, a new license is needed to express the rights of the recipient. As the content is passed along, new sets of conditions and permissions may come into play. For example, a publisher might attach a license to a course pack for use on a PC that grants a school district the right to distribute the course

¹² See the NSDL Reusable Learning Project Web site [42] for a discussion.

pack, provided they pay a license fee and that no more than one thousand copies are made in total. This is called a *distribution* license. When the district distributes the course packs to individual schools or classes, it might create new licenses that allow a fixed number of copies to be made but that does not have a payment condition. This is a second distribution license. When a copy is downloaded to a student's computer, the right to make a copy might be removed completely. The student receives a *usage* license.

Rights Expressions and Rights Expression Languages

A rights expression is a machine (and human) readable expression of what can be done with content under what conditions. Licenses can be written using rights expressions. A *rights expression language* is a grammar and vocabulary for expressing rights in a standardized format¹³. Standardization is needed so that different components of an ecosystem can communicate and uniformly interpret rights. The most widely recognized rights expression languages¹⁴ are the MPEG-REL (Moving Pictures Expert Group – Rights Expression Language) [21] and ODRL (Open Digital Rights Language) [33].

Persistence

Persistence refers to the ability of a rights expression or identifier to be retained as content moves from one system to another. Persistence is an important underlying content that, as the scenarios point out, becomes crucial in ecosystems that involved distributed networks. Persistence can be achieved (for rights) by associating licenses with content using rights expressions.

Persistent is not the same as constant. Different rights apply to different users, so different usage licenses may be granted to different students in compliance with the same distribution license. For example, a graduate student acting as an instructor may be granted the right to annotate and re-distribute content, whereas a student enrolled in a class may not be. Persistence includes the concept that rights can be defined, distributed and acquired as content moves through an ecosystem.

Tracking (by Learning Management Environments)

In the learning technology world “tracking” refers to the ability of a delivery system such as a learning management system or course management system to record data on test scores and time spent in an activity. Standards such as SCORM [1] enable data of this form to be communicated between content and a delivery system in a way that is initiated and controlled by the content rather than by the system. This is necessary if the same content is to run and exhibit the same behavior on multiple systems.

Encryption

Encryption is the process of encoding data so that only an intended recipient can read it. Encryption plays a role in authentication and in data protection, both of which are used in DRM.

¹³ The *grammar* may be considered as separate from the *vocabulary*. For example, in the MPEG REL standard, the vocabulary is encoded in a *rights data dictionary*.

¹⁴ Educational requirements for Rights Expression Languages have been developed by the IEEE Learning Technology Standards committee and mapped to MPEG-REL and ODRL [17]. An extension to the MPEG-REL, based on this work, is being developed by an ISO committee [46].

Authentication and Authorization Services

Authentication is the process of establishing the identity of a user. Enterprise systems typically rely on one or more services to do this. Increasingly, institutions are implementing “single sign on,” which means that users authenticate once, and do not have to provide a login ID and password (i.e. do not have to authenticate) each time they access a new system.

Authorization is the process of determining what a user is permitted to do. Authentication is often the first step.

Single sign on does not solve the problem of authenticating when accessing *external* content. Shibboleth [18] addresses this problem by providing a way for one institution to obtain authority from a trusted partner institution. The Open Knowledge Initiative [34] also addresses authentication and authorization, providing a standardized way for educational applications to access institutional services.

In existing rights management frameworks, users are typically authorized to perform certain actions with content based on their roles within an institution or course (student, auditor, professor, teaching assistant, etc.). A user’s role is determined on the basis of established identity (authentication) and then used to determine what the user may do (authorization). Alternatively, authorities are assigned directly to users, for example by a trusted partner institution using Shibboleth.

This entire approach is sometimes called *role-based authorization*. The difficulty with it is that the permissions are associated with users, not with content. Typically, *access* is the only permission that is effectively managed through role-based authorization and even that involves placing content into a particular area of a repository or associating with a particular course within a learning management environment. Role-based authorization has difficulty addressing distribution rights, attribution requirements, and copy protection. It also requires human intervention to put content in the appropriate location as it moves from one part of an ecosystem to the next. A lot can be done with role-based authorization, but its limitations should be recognized.

Persistent Unique Identifiers and Registries

Persistence throughout and across ecosystems depends in part on the ability to uniquely identify content. Several systems have been proposed for this, many of which involve *handles* and *registries*. A registry is a single, stable location that stores information on content, including the location from which it can be accessed. A handle is a pointer to a registry that includes an identifier *provided by the registry* for a registered piece of content. This system provides identifiers that are more dependable than direct pointers to content, i.e. than URL’s. If content providers use a registry, it also provides a means to resolve redundant references. Registries can potentially associate metadata with content, including rights metadata.

A number of persistent unique identifier initiatives are underway. The most widely known is the Digital Object Identifier system [11, 47, 48]. The Advanced Distributed Learning initiative has plans to create registry systems for learning objects [22].

License Registry

A *license registry* is a place where licenses may be registered, permanently stored and readily accessed. A license registry could be used to associate licenses with content. The Creative Commons [8] offers an example. Any user can register creative commons licenses on the site. License registries are another means to associate rights to content in a persistent fashion.

Financial and Other Services

In the corporate world, learning management systems integrate with financial systems, human resources systems, and other “enterprise systems” to manage access to content based on departmental charge-backs, user fees, manager permissions and other factors. The market models that underlie a DRM ecosystem can necessitate using these types of services in the educational world as well.

5 Conclusion

Digital rights management – the management of intellectual property rights through using digital technology - is needed for the development of the knowledge economy in education [29, 41]. It is needed to promote knowledge sharing as much as it is to protect content from unauthorized use.

The ecosystem model presented in this white paper provides a structure for clarifying DRM requirements, identifying what technology is involved and what gaps still exist. Applying the model is a valuable first step in understanding the challenges and opportunities faced by any institution or organization contemplating a DRM implementation.

As one starts to apply the model, several things become apparent. First, rights management can be very complex. Second, existing frameworks for digital rights management – primarily using “role-based authorization” – have limitations, particularly in a distributed network environment. This supports a movement towards “persistent” methods that associate identifiers, rights and conditions directly to content. Third, the standards and services required to implement persistent methods and to apply DRM to market models other than a retail model are just starting to emerge. This presents implementers with the dilemma of deciding what can be done in the real world today while managing the risks associated with a changing environment.

DRM is a huge and complex subject that this white paper has attempted to consolidate into a simple ecosystem model. But every box and arrow in the model presented in Figure 1 is worthy of at least a chapter, if not a book, of its own. The references that follow include books, articles, and Web sites that allow the subject to be explored more fully.

6 References

1. ADL (2004). *Advanced Distributed Learning initiative, Sharable Content Object Reference Model (SCORM)*. Available from the Web site <http://www.adlnet.org>
2. Brandon-Hall (2004). Publications listed on the Brandon-Hall Web site. <http://www.brandonhall.com/public/publications/index.htm>.
3. Byrne, T. (2002). "The CMS Report", CMS Works Inc., 3rd Edition, Autumn 2002.
4. COLIS (2004). *Collaborative Online Learning and Information Services*. Web site. <http://www.colis.mq.edu.au>.
5. Collier, G.(2002). "eLearning Application Infrastructure", Sun Microsystems, March 2002. http://www.sun.com/products-n-solutions/edu/elearning/eLearning_Application_Infrastructure_wp.pdf
6. ContentGuard (2004). *ContentGuard*. Web site. <http://www.contentguard.com>
7. Cope, Bill and Freeman, Robin editors (2001). *Digital Rights, Management and Content Development*, Common Ground Publishing, 2001
8. Creative Commons (2004). *The Creative Commons*. Web site. <http://www.creativecommons.org>.
9. Dalziel, J. (2003). "The Learning Object Lifecycle", Macquarie E-learning Centre of Excellence, May 2003. www.melcoe.mq.edu.au
10. DMDsecure. *Digital Media Distribution Secure*. Web site. <http://www.dmdsecure.com>
11. DOI (2004). *The Digital Object Identifier System*. Web site. <http://www.doi.org>
12. Downes, Mourad, Piccariello & Robson (2003) "DRM in E-learning: Problem Statement and Terms of Reference", E-learn 2003 Proceedings. www.eduworks.com/Documents/DRM_in_E-Learning.pdf
13. Giant Steps. (2004). *References in the Giant Steps Bibliography*. <http://www.giantstepsmts.com/drmbiblio.htm>
14. Hulme, George (2003). "Who Needs to Know?" Information Week, June 9, 2003 www.informationweek.com/story/showArticle.jhtml?articleID=10300293
15. Hyperdictionary. (2004). *Hyperdictionary*. Web site. <http://www.hyperdictionary.com>
16. Iannella, Renato (2001). "Digital Rights Management (DRM) Architectures" D-Lib Magazine, June 2001, Volume 7 Number 6. <http://www.dlib.org/dlib/june01/iannella/06iannella.html>
17. IEEE LTSC (2004). IEEE Learning Technology Standards Committee. Web Site. <http://ltsc.ieee.org>.
18. Internet2 (2004). *The Shibboleth Project*. Web site. <http://shibboleth.internet2.edu>
19. ISBN (2004). *International Standard Book Number*. Web site. <http://www.isbn.org>
20. ISSN (2004). *International Standard Serial Number*. Web site. <http://www.issn.org>

21. ISO/IEC (2004). *Information technology -- Multimedia framework (MPEG-21) - Part 5: Rights Expression Language*. ISO/IEC 21000-5:2004.
<http://www.iso.ch/iso/en/CombinedQueryResult.CombinedQueryResult?queryString=21000-5>
22. Kraan, W. (2004). *ADL to Make a "Repository SCORM."* Centre for Educational Technology Interoperability Standards.
<http://www.cetis.ac.uk/content2/20040219153041>
23. Jennings, Tim (2002). "Defining the Document and Content Management Ecosystem," Butler Direct Limited, September 2002
24. LITE. (2004). Michigan State University Laboratory for Instructional Technology in Education. Web site. <http://www.lite.msu.edu>
25. Lynch, C. (2003). *Institutional Repositories: Essential Infrastructure for Scholarship in the Digital Age*. Association of Research Libraries. Monthly report 226. February 2003.
<http://www.arl.org/newsltr/226/ir.html>.
26. Masie Center (2002). *"Making Sense of Learning Specifications and Standards."* Second edition, March 2002. http://www.masie.com/standards/S3_Guide.pdf.
27. McCullagh, Adrian and Caelli, William (2000). "Non-Repudiation in the Digital Environment", *First Monday*, volume 5, number 8, August 2000.
http://www.firstmonday.dk/issues/issue5_8/mccullagh/
28. NLII (2004). Educause National Learning Infrastructure Initiative, Learning Objects (NLII 2002–2003 Key Theme). Many references given.
<http://www.educause.edu/nlii/keythemes/learningObjects.asp>.
29. Norris, Mason, Robson, Lefrere & Collier. (2003). *A Revolution in Knowledge Sharing*. Educause Review, September/October 2003, 38 (5), 14 – 26.
30. NSDL (2004). *National Science Digital Library*. Web site. <http://www.nsdli.org>
31. OAI (2004). Open Archives Initiative. Web site. <http://www.openarchives.org>
32. OCLC (2004). *Persistent Uniform Resource Locator*. Online Computer Library Center. Web site. <http://purl.oclc.org>
33. ODRL (2004). *Open Digital Rights Language Initiative*. Web site. <http://www.odrl.net>
34. OKI (2004). *The Open Knowledge Initiative*. Web site. <http://web.mit.edu/oki>.
35. Overdrive (2004). *Overdrive DRM Solutions*. Web site.
http://www.overdrive.com/drm_solutions
36. Rehak, D. (2003). "A SCORM Roadmap: SCORM's Technical Evolution" Presentation from the Learning Systems Architecture Lab web site – www.lsal.cmu.edu
37. Rights Express (2004). *Rights Express*. Web site. <http://www.rightsexpress.com>
38. Robson, R. (2002). "The 'Rights' Stuff", Techlearn presentation, November 2002

39. Robson, R. (2003). "Digital Rights Management and Educational Content", Eduworks, workshop given at EdMedia June 23, 2003 - workshops.eduworks.com/EdMedia2003/
40. Robson, R. (2003). "The Teach Act and the MPEG Rights Expression Language", Eduworks, 2003 - http://www.xrml.org/reference/TEACH_REL_WP.pdf
41. Robson, Norris, Lefrere, Collier, & Mason. (2003) *Share and Share Alike: The E-Knowledge Transformation Comes to Campus*. Educause Review, September/October 2003. Online only. <http://www.educause.edu/ir/library/pdf/erm0351.pdf>
42. Robson, Muramatsu & Collier (2004). *The Reusable Learning Project*. Web site. <http://www.resuablelearning.org>.
43. Rosenblatt, Bill (1997). "The Digital Object Identifier: Solving the Dilemma of Copyright Protection Online," in the Journal of Electronic Publishing (University of Michigan Press), volume 3, issue 2, December 1997
44. Rosenblatt, Bill and Dykstra, Gail (2003). "Integrating Content Management with Digital Rights Management," Giantsteps Media Technology Strategies and Dykstra Research, May 2003
45. Rosenblatt, Trippe and Mooney (2002). *Digital Rights Management – Business and Technology*, M & T Books 2002
46. SC36 (2004). ISO/IEC JTC1 SC36 Working Group 4, Web Site. <http://mdlet.jtc1sc36.org/>.
47. Scharf, Davida (2002). *The DOI is coming: tracking digital information*, Information Outlook Magazine, Sept 2002. http://www.findarticles.com/cf_dls/m0FWE/9_6/91913053/p1/article.jhtml
48. Slater, Jenny and Barker, Phil (2003). *Unique Identifiers for Metadata Records*, CETIS (the Centre for Educational Technology Interoperability Standards, last modified February 2003. <http://metadata.cetis.ac.uk/guides/uids.doc>
49. Ternier, Stefaan and Duval, Erik (2003). "Web services for the ARIADNE Knowledge Pool System" Dept. Computerwetenschappen, Katholieke Universiteit Leuven, November 2003. <http://rubens.cs.kuleuven.ac.be:8989/ariadne/CONF2003/papers/TER2003.pdf>
50. Thomson Corporation. (2004). South-Western Book Division of Thomson Corporation: eBook Glossary. <http://www.swcollege.com/ebooks/glossary.html>.
51. U.S. Copyright Office (1998). *Digital Millennium Copyright Act (Summary)*. <http://www.copyright.gov/legislation/dmca.pdf>
52. U.S. Copyright Office (2001). Copyright Law of the United States, Text Revised as of July, 2001. <http://www.copyright.gov/title17/>
53. U.S. Copyright Office (2002). The TEACH Act Text. <http://www.copyright.gov/legislation/pl107-273.html#13301>
54. XRML (2004). *Extensible Rights Markup Language*. Web site. <http://www.xrml.org>.