Digital Rights Management: Tools and Applications for Implementing DRM in a Digital Ecosystem

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Overview

In a companion ECAR research bulletin, “Digital Rights Management: An Ecosystem Model for the Education Community,” the authors introduced a model for analyzing digital rights management (DRM) scenarios, requirements, roles, and technology options. In that bulletin, the model was briefly described and applied to a number of scenarios relevant to the education community. This bulletin examines the components of the ecosystem model in greater detail, pointing out where policies need to be set and what technology should be considered in implementing rights management.

Figure 1 shows the DRM ecosystem model. It depicts how rights flow through the ecosystem and defines a set of actors, applications, standards, and services relevant to the education community. The model includes the following components:

**Rights Management Environment:** Rights management takes place in an environment composed of the law, policy, practice, market mechanisms, organizations, roles, and community expectations. 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.

**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 a part.

**Tools and Applications:** Content is created, distributed, acquired, and used through 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 processes 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.
A DRM ecosystem for education operates within a particular set of environmental conditions that include the law, policy, practice, market mechanisms, organizations, individual roles, and community expectations. Recognizing and understanding these factors is the first step in a successful DRM implementation.

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 complicated and lead to conflicting goals and measures of success, but it is necessary to acknowledge and face this complexity.

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.

Before a community can implement a rights management ecosystem, it must identify and agree on the underlying market and intellectual property management models. 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 unique rights management and tracking requirements.

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; the number of times a work can be copied, read, printed, or redistributed; the time frame during which the rights can be exercised; and specifying the attribution required if the work is quoted or reused in any way.

DRM will be of the most value in an environment where simple, small, and frequent transactions involve 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 through traditional negotiations and contracts, then automation is not necessary. Not all types of rights transactions are appropriate for automation.²

Technology-based DRM is needed in a distributed digital market, but DRM technology is in the early stages of development. 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.

**Content Life Cycle**

Digital rights management occurs in the larger context of content management. In making decisions concerning rights management, it is important to examine how content is managed and, in particular, which aspects of content management are relevant. Table 1 provides a basic model of a content management life cycle and some general rights issues associated with different parts of the life cycle. More complete models of content life cycles and content management can be found in the books and articles referenced at the end of this research bulletin.³–⁷
### Table 1. Content Life Cycle and Rights Issues

<table>
<thead>
<tr>
<th>Content Life Cycle</th>
<th>Create Content</th>
<th>Offer Content</th>
<th>Acquire Content</th>
<th>Use Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author</td>
<td>Create new content, from scratch or by modifying existing material</td>
<td>Licenses should be defined when the content is created. Supporting technology should be considered. Rights need to be consolidated when content is assembled from multiple sources.</td>
<td>Rights information can be used as a search criterion. Rights must be acquired before content can be used.</td>
<td>Rights determine if and how content may be used. Rights may be enforced when content is used.</td>
</tr>
<tr>
<td>Assemble</td>
<td>Bring together works from one or more sources and assemble them into a coherent learning module</td>
<td>Rights should be published, cataloged, and distributed together with content. Rights data should be preserved throughout publishing and distribution. Use licenses are different from distribution licenses.</td>
<td>Acquire access to the content in the format needed to support the desired use</td>
<td>Display, interact with, and otherwise use content</td>
</tr>
<tr>
<td>Publish</td>
<td>Prepare and issue content for public (or institutional) distribution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catalog</td>
<td>Classify and record attributes of content</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distribute</td>
<td>Distribute content to the targeted users</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### What Has Changed? The Nondigital Case

In the nondigital world, the physical manifestation of content (a book or an article in a journal) acts both as a rendering of the content and as a physical token of exchange for the rights associated with the content. The content is a “work,” and the physical book is an “expression” of the work. Three fundamental changes affecting rights management occur when the work is expressed in digital rather than physical form.

First, a book or journal article can only be read by one person at a time, thereby effectively enforcing a “single user” license. Physical copies could be made, but the quality of those copies will not be as good as the original, and businesses that provide copy services will refuse to make multiple copies of a book or journal article in the absence of documented permission. Digital content, on the other hand, can be copied with perfect quality, and these copies can be easily transmitted to hundreds or thousands of others through e-mail lists and Web download sites.

Second, the exchange of a physical book or journal is tracked as it moves through publishers, bookstores, and libraries to the individual user. The physical nature of the book supports this tracking and control even in the absence of automated purchase and
inventory systems. This same level of tracking of individual copies of content is not yet available in the digital world, and there are no easy ways to control the number of digital books on the shelf.

Third, the nature of the Web and digital content allows organizations and individuals to easily participate in a digital network of distribution. The distribution of physical books and articles requires the establishment of physical means of transportation and inventory, and each copy’s handling involves many steps. In the digital world, wide distribution of digital assets can be carried out by one person sitting at a desk. There are virtually no barriers to participation in a network of digital content distribution; therefore, rights holders cannot count on trusted business relationships to prevent the unauthorized use and distribution of their content.

In light of these differences, the effective management of rights for digital content requires technological solutions. All the software involved in the authoring, distribution, and rendering processes should incorporate rights management technology, allowing those applications to recognize, enforce, and pass on these rights. Movement toward this level of rights management automation is occurring, with protection mechanisms being built into software such as Adobe Acrobat, Apple iTunes, Windows Media Player, and Microsoft Office; however, this movement is in its early stages, and industry standards are just beginning to emerge.

Tools and Applications

The content life cycle is supported by software that falls into several product categories. Rights management capabilities must be built into or work in concert with this software if rights management is to be automated. In a perfect digital world, authoring and assembly tools would allow authors to easily define usage and distribution licenses for their content at the time it is created, and these expressions would be in a standardized form that could be interpreted by other technology used to render, print, copy, or edit the content. It is therefore important to understand the various product categories and what the software provides.\(^{10,11}\)

Authoring tools, used to create and modify content, 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 (for example, 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 (for example, by explicitly defining rights associated with a new or derived work). Authoring tools must also be able to interpret and
potentially enforce rights (for example, by preventing existing content from being copied or edited without authorization).

The term “content repository” covers a wide range of systems and services that store, manage, and provide 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.

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 interpret, process, preserve, and transmit information about rights. Cataloging tools must handle rights metadata, and interfaces to repositories may be called on 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” and therefore only accessible to authorized users from within an institution’s IT environment, then a combination of password protection and access control (based on the role of a user within an institution) can form an effective rights management framework for many purposes. When content is required to pass across the institutional boundary, however, either as content provided to others or as content obtained externally, then rights must be associated with content in a persistent and standardized way. The issue of persistent rights is discussed in more detail below.

Learning management environments (or systems) are designed to organize and deliver structured learning and to track students’ progress toward learning goals. Course management systems and virtual learning environments are products that instructors use to assemble online courses with syllabi, reading materials, chat rooms, e-mail lists, and tests. These products also maintain class lists and authenticate users.

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 typically include some content repository functionality. The access control provided by these systems suffices for many, but not all, rights management purposes. Rights management challenges increase when a learning management environment interacts with external content repositories.

Ultimately content is accessed through a personal computing environment on a workstation, desktop, notebook or tablet computer, or on a handheld device. This environment includes applications that enable content to be displayed, printed, copied, modified, and shared with others. The enforcement function of DRM focuses on protecting content from the applications that could carry out these processes without
authorization. As a result, the enforcement aspect of DRM has a significant focus on the control of personal computing environments.

**Rights Management Services and Standards**

The DRM ecosystem model identifies 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 automating these functions.

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 is 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. For an example, see Creative Commons, which has defined a small number of standard licenses that can be used for defining and distributing information about rights. Without an appropriate license, users cannot legally modify content for reuse and may not be able to use the content at all.

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 pack, provided it pays 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 without 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.

A rights expression language is a grammar and vocabulary for expressing rights in a standardized format. This allows the creation of machine (and human) readable expressions of what can be done with content under what conditions. Standardization of rights expression languages and semantics is needed so that different components of an ecosystem can communicate and uniformly interpret rights. The most widely recognized rights expression languages are the ISO MPEG REL (ISO IEC 21000-5) and Open Digital Rights Language (ODRL).

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 concept that becomes crucial in ecosystems that involve distributed networks. Persistence can be achieved (for rights) by associating licenses with content using rights expressions.
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 redistribute content, whereas a student enrolled in a class may not be.

Tracking refers to the ability of the components of the ecosystem to be aware of the relevant usage of digital content by other components of the ecosystem. In the learning technology world, tracking also refers to the ability of a delivery system such as a learning management system or course management system to record data on the time spent in an activity and the outcomes for learners. Standards such as SCORM enable data of this form to be communicated between content and a delivery system in a way that works for any conforming content running in any conforming environment. This allows the same content to run and exhibit the same behavior on multiple systems.

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.

**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 need to provide a login ID and password (specifically, they do not have to reauthenticate) each time they access a new system.

Authorization is the process of determining what a user is permitted to do, once they have been authenticated. 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, and so forth). A user’s role is determined on the basis of established identity (authentication), and the role is then used to determine what the user may do (authorization). Alternatively, authorities may be assigned directly to users, for example by a trusted partner institution using Shibboleth. Shibboleth addresses the problem of providing authentication across organizational boundaries by providing a way for one institution to obtain authority from a trusted partner institution. The Open Knowledge Initiative also addresses authentication and authorization, providing a standardized way for educational applications to access institutional authentication and authorization services.

This entire approach is sometimes called role-based authorization. From a rights management perspective, the shortcoming is that the permissions are associated with users, not with content. Typically, controlling access to digital content in a role-based authorization environment involves placing content into a particular area of a repository or associating it 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—it is an important piece of the rights management puzzle—but its limitations should be recognized.

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 the concepts of “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 approach provides identifiers that are more dependable than direct pointers to content (URLs, for example.) Registries also provide a means to resolve redundant references and can potentially associate metadata with content, including rights metadata.

A number of persistent unique identifier initiatives are under way, including the widely known Digital Object Identifier project. The Advanced Distributed Learning initiative is considering the creation of registry systems specifically designed for learning objects.

A license registry is a place where licenses associated with content may be registered, permanently stored, and readily accessed. License registries are another means to associate rights to content in a persistent fashion and provide licensed users of content with a way to access their content and their licenses without having to retain a copy of the content and its associated license in their own computing environments. Creative Commons offers an example of a license registry, allowing any user to register Creative Commons licenses on their site.

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.

What It Means to Higher Education

Digital rights management is a complex subject that the authors have attempted to consolidate into a simple ecosystem model. Every box and arrow in the Digital Rights Management Ecosystem Model (Figure 1) is worthy of at least a chapter, if not a book of its own. DRM, however, is an increasingly important topic that must be considered by a wide range of higher education decision makers, as well as by those specifically tasked with managing content and providing the technology to support content management. Therefore, it is important to have relatively simple yet comprehensive models that can be readily understood by a range of people to provide a framework for conversations, formal analysis, and decision processes.

Effective digital rights management is as much about enabling the use and sharing of digital content as it is about protecting content from unauthorized uses. DRM is essential
to developing a digital knowledge sharing environment, where researchers and educators can easily determine what rights they have to use content from others and can also associate rights with their own content and trust that these rights will be respected.

Colleges and universities should be evaluating their practices, technology, expectations, and risks in this area. The technology affecting digital content is changing rapidly, as are the nature and practice of intellectual property laws related to digital content. The policies, procedures, and technologies that support rights management for physical content are often not appropriate for supporting rights management in a digital age, and an ongoing shift of responsibility for rights management from societal institutions to technological solutions is expected.

Key Questions to Ask

- Does my institution have a plan for addressing digital rights management issues?
- Is there a common conversation about rights management occurring at my institution that includes all groups involved in digital content management and supporting technologies?
- What internal and external digital content repositories are educators, researchers, and students using at my school, and what rights management capabilities do these repositories provide? Repository here is meant in its broadest sense: any collection of digital content.
- What authentication and authorization technologies are used to control access to content repositories, and how do these apply to content that is shared across organizational boundaries?
- Should my institution consider involvement in prototype projects to gain knowledge and practical experience in this area?

Where to Learn More

- Collaborative Online Learning and Information Services (COLIS), <http://www.colis.mq.edu.au/>.


Endnotes


14. The grammar may be considered as separate from the vocabulary. For example, in the ISO MPEG REL standard, the vocabulary is encoded in a rights data dictionary (ISO/IEC 21000-6).
15. Educational requirements for rights expression languages have been developed by the IEEE Learning Technology Standards committee and mapped to ISO MPEG REL and ODRL. A learning, education, and training profile of the ISO MPEG REL is being developed by the ISO IEC JTC1 SC36 WG4.


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