A DRM Solution Based on Social Networks and Enabling the Idea of Fair Use

Sławomir Grzonkowski, Brian Ensor, Sebastian Ryszard Kruk, Adam Gzella,
Stefan Decker and Bill McDaniel

***Abstract*—Fair use policy allows legal owners to share products they bought with their acquaintance; it is based on the assumptions that the owners pass an original product and they cannot use it at the same time.**

In the digital world, we can hardly apply those assumptions since they are based on a physical availability. Furthermore, digital content providers want to have control over the distribution of their products; thus, Digital Rights Management (DRM) systems do not assist and even forbid sharing.

In this paper, we describe a DRM system that takes advantage of a social network. We will describe how a model of an existing on-line social network, which includes users' roles and trust relationships can be applied. We will present that roles and trust metrics, maintained by the users can be coupled with sharing policies controlled by the content providers. Our solution gives flexibility to the users; it still also leaves, enough control over the content distribution to the content providers. We will show how to extend an existing Digital Rights Language (DRL) to support properties defined in social networks metadata and compare it with other approaches. Finally, we will discuss if our solution introduces the fair use policy to the digital world.

***Index Terms*—DRM, Social networks, Fair Use**

I. Introduction

DIGITAL Right Management (DRM) systems have been in existence since the early 1990s; their initial aim was to control the distribution of consumer media by protecting the content. Since 1998, all such systems are supported by the controversial Digital Millennium Copyright Act (DMCA) [14]. The act is important for the USA where the creation or distribution of DRM circumvention tools is banned. The same law was applied in the European Union several years later by European Union Copyright Directive (EUCD) [21]. Some critics claim that the European act is even more restrictive [8] than its predecessor. Together with those directives, consumers lost some of their physical world privileges like fair use or first sale. Existing DRM systems do not support fair use; they offer only limited solutions. Usually, a purchased media file can be played only on one user's devices. In the physical world, if we buy a magazine, we can read it, lend it or even sell it; however, we cannot legally copy it or change it without the permission of the copyright holder. Such rules, unfortunately, do not apply to the digital world so far.

We claim that DRM should respect both the creativity of talented people and also the rights of the customer. Users should be able to share media not only among their personal devices, but also with their acquaintances. However, only one copy at one time should be allowed.

Authors are affilated with Digital Enterprise Research Institute, National University of Ireland, IDA Business Park, Galway, Ireland. Homepage: http://deri.ie, email: firstname.lastname@deri.org

A. Physical and Digital Worlds' Limitations

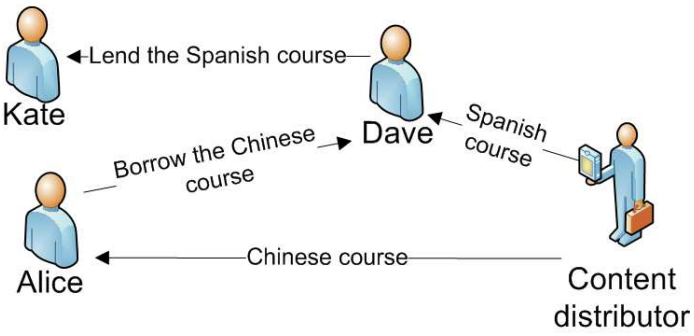

Fig. 1. A DRM within an eLearning context

Figure 1 presents a scenario that is characteristic for an eLearning environment. Dave and Alice are customers who bought some on-line courses. They would like to share the courses with friends. Dave lent his Spanish course to Kate and at the same time he borrowed a Chinese course from Alice. Therefore Dave has only access to the Chinese course. Although Kate did not buy anything, she can learn Spanish. Alice is unable to learn anything because she loaned her access to Dave. In order to learn, she must ask him to give access back to her.

Such a situation is common in the physical world. However, if we consider the same situation in the digital world, many limitations will appear. For example, in the given example people are unable to borrow books one another although it is common in the physical world. Moreover, reselling also is not supported or even forbidden. On the other hand, the digital world allows to make two perfectly identical copies of any digital media file with very little cost and effort. In addition, any digital media do not get used up and do not go stale.

Such differences are crucial from both customers and content providers' perspective. The consumers want to keep the old fair use privilege, whereas the providers want to keep control over the amount of sold products. At the same time, all of them want to benefit from the modern technologies and conveniences.

B. Paper Overview

The remainder of the paper is organized as follows. Section 2 introduces the reader to social networks. Section 3 describes Digital Rights Management (DRM). In section 4

we discuss a DRM based on social networks and its impact on Fair Use and in section 5 we describe how to create such a system using existing technologies. Section 6 evaluates our approach and section 7 presents related works. Finally, section 8 conclude and describe future work.

II. On-Line Social Networks

A social network is a graph that represent a social structure. Nodes in such a graph are people and connections between nodes represent relationships. Social networks are often applied by the internet communities to access control or to create on-line groups of friends. In this section we will present basic concepts and properties of on-line social networking.

A. FOAF

FOAF (Friend Of A Friend) [4] is a project for machine-readable modeling of homepage-like profiles that include social networks. It is mainly used for describing people and connections between them, but could be also used for groups, organizations, and companies. It allows semantically meaningful data sharing between varied computing environments.

The FOAF technical specification [5] is currently an official specification of the W3C organization; it defines the core concepts of FOAF such as 'homepage', 'name', 'gender', etc. One of the most important term is 'knows'; it allows linking the FOAF profiles and creating social networks.

The FOAF vocabulary is based on RDF and is defined using OWL. Therefore, it is machine readable and can be processed by software. Moreover, the FOAF standard can be easily extended with new vocabulary. In addition, the standard is widely used by Internet communities for storing and sharing information about web users.

B. Orkut

Various community sites could export profiles of their users in FOAF; most of these sites, however, operate on models that are slightly incompatible with FOAF.

Orkut [12] is a social network site, part of Google. The friendship relations between Orkut users can be of one of predefined types: best friends, good friends, friends, acquaintances and haven't met. This solution allows users to clearly define level of their relationships with other users, as long as this relationship is a friendship. It is impossible to identify other types of relations between the users, such as family, or professional.

C. Community Driven Access Rights

One of the primary functions of many web applications is to assure access rights control to particular resources defined with access control lists. This community driven access control system takes into account not only direct contacts of the resource's owner but a whole social network. A scenario where a very good friend of a very good friend is more trustworthy than a direct barely known colleague is possible.

D. Users' Roles and Relationships within a Social Network

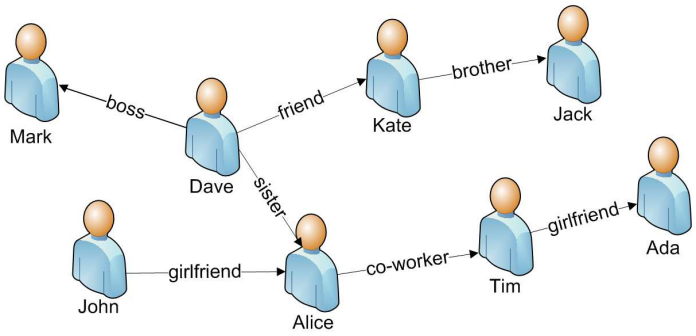

Fig. 2. A labeled social network graph

A labeled social network graph gives more meaningful information to computers than a simple FOAF-model with just marked *knows* values. In social communities people not only know one another, but they are also actors that perform various roles. Furthermore, one person can perform many roles: for example a friend, co-worker, girlfriend, etc. Roles are related to relationships, people participate in a wide range of relationships: family relationship, friendship, formal relationships, etc. The process of adding additional labels to a social network graph is illustrated on figure 2. The graph shows that Alice works with Tim; she is also a sister of Dave's, and a girlfriend of Johns. The nature of those relationships is both informal and formal and this information can be used for many purposes.

E. Access Control Based on a Social Network

A digital content provider can agree, for example, that Alice can share an ebook with her family but not with friends. In another case, the same provider can apply other kind of constraints and allow her to share products with Tim, who is her co-worker. Social networks have potential to provide precise control over content distribution.

- Total control - when a user is not allowed to share his content
- Total openness - when a user is allowed to share his content with everyone
- Limited connection - when content providers accept sharing, but the sharing is limited by a social network distance; e.g., a user and all his direct friends.
- Roles-and-relationships based - is it a situation when a user is allowed to share his content with users who perform particular roles: for example, they are co-workers or family members.

F. FOAFRealm

FOAFRealm [26] is an identity management system based on FOAF. It uses FOAF for storing information about users. It provides functionality to authenticate users and manage their identity data.

FOAFRealm introduced a few extensions with a friendship to the FOAF standard. One of them that is extending

the *foaf:knows* property with friendship level to provide fine grained community driven access rights.

Friendship relation can be naively modeled with a digraph, where a direct link from A to B means 'A knows B'. Such representation is provided by the standard *foaf:knows* property. It does not cope with the important features presented in the real social networks such as quality and context of friendship relation.

To represent a social network more thoroughly each relationship can be annotated with metrics defining how long the friendship lasts, frequency of meetings, average time spent together. In some social networks, like Orkut [12] users are able to set some predefined values to express the friendship type. FOAFRealm introduces a smooth scale to describe the connection between users more precisely. With a new *foaf:friendshipLevel* property (which reifies the standard *foaf:knows* property) it is possible to express the level of friendship from 0% (haven't met) to 100% (best friend).

FOAFRealm is an example of a system which has implemented community driven access rights. A person is granted access to a resource when the friendship level, and the distance between the resource owner and the service requester meet required constraints. The distance is the length of the shortest path from the owner to the requester.

The final friendship level is computed by multiplying all intermediate trust values between the resource owner and the requester. Access rights can be delegated further only if other requesters conform to the given distance and friendship level constraints.

An example illustrating FOAFRealm policies is described in section X.

III. Digital Rights Management

Digital Rights Management (DRM) as a term is often used by publishers and refers to a set of technologies that control usage of digital data. Therefore, the scope of DRM if very wide and it covers aspects of law, content distribution, encryption, hardware protection, etc.

A. DRM Solutions

This section describes three existing DRM systems and their approach to fair use. The described systems have been developed by three major companies: Apple, Microsoft, and IBM. However, more and more companies are interested in DRM solutions; for instance, Adobe is pushing forward a DRM technology within its Adobe Reader and Nokia has applied InnerTrust rights-system in their mobile solutions.

A.1 Apple

A DRM created by Apple is called FairPlay. It is embeded in several Apple's products. The most popular are iPod [1], iTunes, and QuickTime. Moreover, iTunes music on-line store also sells music using the FairPlay. The company has an agreement with top American music industries. The most important condition of the agreement states that Apple has to use DRM to distribute content. In order to store music, Apple uses "Protected AAC Files". The files are in MPEG-4 format encrypted using AAC format. All algorithms applied in the encryption scheme are public: AES (Rijnadel) [19], MPEG-4 file format. The exception to using public encryption algorithms was the user's key database component but the applied algorithm was broken by Jon Lech Johansen, who is also known for breaking DeCSS [7] standard applied in DVD players.

Although an iPod allows the sharing of music among 5 authorized devices and also allows a user to copy it to a CD audio any number of times, several illegal systems that can omit the DRM protection exist: De-DRMS, PlayFair, QT-FairUse, and Hymn. Therefore Steve Jobs, Apple CEO, recently published his 'Thoughts on Music' [13]. He demands the 4 biggest American companies to cancel the DRM agreement. His calculation shows that the market of iPods is only 10% of the total music market. In addition only 3% of music files stored in iPods were bought legally. Furthermore, the encryption scheme relies on a secret that can be broken relatively quickly by the Internet community. His conclusion is that currently DRM in the music market does not work because it covers a very small part of it.

A.2 Microsoft

Microsoft offers Windows Media Rights Management (WMRM) [9]; this solution is freely available, and therefore it is also the cheapest choice to start; it works, however, only under the Windows Operating systems and thus supports only Microsoft's media formats: WMA for audio, and WMV for video purposes. The system works both with downloadable and stream-based files. A user's identity in this system relies on a unique identification number that is computed using the user's hardware; it is stored in a DLL file. This idea, of course, affects the fair use doctrine since the identification number depends on a single device and thus files can be played only on one particular device. The core concept of Microsoft's approach is a software license that is responsible for specifying users' rights and determining how many times a file can be played, possibilities of transferring a file to other device, expiration date, permission to burn a CD and others.

A.3 IBM

EMMS is a DRM solution presented by IBM. It offers an open architecture that enables content providers to adjust the system to future needs. The technology can be easily extended with watermarking, compression, or encryption. EMMS was successfully tested in 1998 in the first broadband music distribution trail. Three years later the technology was applied to NTT DoCoMo [10], the world's first mobile music service. The system was also successfully extended with SCORM and LOM metadata in order to apply the solution in the e-Learning context [29]. The system supports MP3, AAC, and ATRAC3. The main disadvantage is lack of support for stream-based contents.

B. Rights Expression Languages

Many current successful DRM developments and implementations contain some form of a well formulated and implemented Rights Expression Language (REL) to assist in the expression and understanding systems have of authorized actions. The REL operates as a formal agreement between systems governing permitted activity which is generated by some defined authority and enforced by another. REL has been developed under competing standards, public and proprietary, with some adopted into commercial DRM solutions. There are a number of competing standards in the area of REL with Extensible Rights Markup Language (XrML) (See section B) and Open Digital Rights Languages (ODRL) as the most notable.

ODRL is an extensible model based on a number of core entities and their relationships. The eleven core entities include: 1) Asset, 2) Party, 3) Permissions, 4) Constraints, 5) Requirements, 6) Conditions, 7) Rights Holders, 8) Contexts, 9) Offers, 10) Agreements, 11) Revoking Rights. Accompanying this is a security model for the security entities of signature and encryption. The Context of the elements provides for significant control over the relationships between entities and the aggregation of elements into Offers and Agreements by permitting the assignment of unique identifiers to the elements and sub-elements. The extensibility of ODRL is also demonstrated by the use of two XML schemas, one for the expression language and the other for the data dictionary. Flexibility of implementation comes with the ability to add new semantics through a data dictionary, extending the existing semantics. One of the most successful implementation of ODRL is the adoption of this standard into the work of the Open Mobile Alliance (OMA) producing the OMA REL as part of their DRM v2 with a focus on mobile technologies.

C. Content Distribution

The mentioned standards support the concept of Super Distribution: the ability to transfer content from one client to another, such as in social sharing of resources. Although the DRMs will support such activity, it is in the area of digitally interpreting Fair Use and expressing the rights of the clients to act within those constraints that are enablers to such activity. Jackson, et al. [25] surveys users' experience with listening and sharing music in comparison with different copyright laws and DRM. In particular, they highlight how 'personal use rights [are] adversely affected by DRMs' and how the current design of DRMs 'restrict personal use activities'. An important facet to their survey was that the music sharing among friends were normally conducted within known networks, but that not all their activity would be permitted under copyright law - their choices in sharing were based on personal preference and simplicity.

During a recent working group conference held by the the Organization for Economic Co-operation and Development [11], members recognized this growing field of user-driven content creation, use and sharing that needs to be addressed: "The question is how to devise rules that allow for the coexistence of market and non-market creation and distribution and foster innovation without blocking downstream innovation." This rules development is clearly recognized by the Digital Media Project (DMP) started by MPEG founder Dr. Leonardo Chiariglione with the issuance of the 'Digital Media Manifesto' in October of 2003 [15]. DMP also recognizes the requirement for social sharing as growing part of an effective DRM; proofed by the listing of 'Mapping of rights traditionally enjoyed by users to the Digital Media space' as one of the four Policy Actions contained in the Major Actions of the Manifesto. DMP continues its work on DRM with the aim to create the DRM Standard and extends the architecture of ISO MPEG REL to help facilitate the growing usage scenarios.

Both ISO MPEG REL and ODRL use Rights Domains in their general form to assist in the distribution of media. These Domains can be of any form, such as: home use, office, friends, library, etc. Sheppard and Safavi-Naini [31] demonstrate the benefit of such a system for use in ubiquitous computing with the extension of the authorized domain with the environmental role. Their review of using an environment role to provide membership to the domain extends the context aware functionality of the domain. This provides the opportunity for a user to be associated to a role that is granted the permissions, and not just to the user themselves. This approach highlights the flexibility of the current standards to facilitate usage in various environments. In particular, there is an apparent fit for extending such technologies to social networks for the creation or extension into social sharing domains; providing you the control to actively share content based on accurate digital representation of copyright restrictions include of fair use opportunity.

IV. DRM with Social Networks

In this section we consider the advantages of a DRM system that uses social networks in order to assist sharing. We discuss creation of such a system with respect to the fair use doctrine. In comparison with a regular sharing system, the main innovation is sharing based on availability: once a user shares a product, the user cannot use it until the product is given back.

To determine if a use is fair, a four factor test must be applied. The test consists on the following questions.

1. The purpose and character of the use, including whether such use is of a commercial nature or is for nonprofit educational purposes;
2. The nature of the copyrighted work;
3. The amount and substantiality of the portion used in relation to the copyrighted work as a whole; and
4. The effect of the use upon the potential market for or value of the copyrighted work.

None of these questions is a decision problem; for example, to evaluate the question 4, we need to involve human expertise to measure the effect on the market. Furthermore, all of the questions belong to the class of non-algorithmic problems and thus we cannot answer the test questions by means of computers.

For many users in the digital world, the main problems are abilities to use a purchased media file on many devices and lend it.

In the physical world the problem is solved by the physical nature of an item; here users can both share content with acquaintances and use it on many devices. However, in the digital world, the copyright holders would like to control the ease of copying and distributing their content. Therefore, we are looking for a reasonable compromise that will be acceptable to both sides: the copyright holders and the customers.

A simple situation where a person has purchased a media file and would like to either share it with an acquaintance or to use it on other personal devices is currently unsupported or even forbidden by most Digital Rights Management (DRM) solutions.

Furthermore, the in the physical world, people are allowed to resell products if they should want to. However, such an ability is not possible in the digital world using existing DRM solutions; Even iTunes [1] music on-line store, which is currently a leading solution, does not allow the transferring ownership.

A DRM system based on social networks can address the aforementioned issues. Firstly, a customer specifies a list of trusted people and devices; this allows the customer to legally transfer the file to those devices and people. However, at the same time, the file should be removed or locked at its source. Secondly, the aim of the user' social network is to notify the content provider where the currently unlocked media file is. Finally, if the user is able to borrow a complete product - not a demo version - before deciding to buy it, our idea will also increase the users' satisfaction with their purchase. Therefore, we expect that this approach will increase the selling of higher quality items.

On the one hand such the proposed system gives various abilities of controlling content distribution: using degrees of separation and trust relationships. On the other hand it gives flexibility of sharing and collaboration to typical users. Our conclusion is that such a solution perfectly satisfies requirements of both sides: the consumers and the content providers.

Moreover, some scientists [30] have noticed that current consumer discontent with highly restrictive DRM may force the content owners to make DRM more consumer-friendly; we believe that a DRM based on social networks is such a more consumer-friendly DRM.

V. Implementation

In previous sections we have identified properties characteristic for social networks; we presented ODRL, a Rights Expression Language (REL). In this section we show how to include social network properties delivered by FOAFRealm within ODRL. Moreover, we will show where to put the FOAFRealm component within an existing DRM architecture.

A. A DRM Conceptual Model

DRM architectures that are described in literature are common for many systems. For instance, Liu [27] propose a typical DRM architecture that consists of four main components:

- The content provider who represents digital rights owner
- The distributor who is responsible for selling the provided content
- The consumer who retrieves the content
- The clearinghouse that is responsible for handling financial transactions and issuing licenses

Another model that was proposed by Erickson [20] consists also of four components: the content server which is similar to the distributor, the license server that acts analog role to the clearinghouse, the rights escrow server that can be compared to the content provider, and the client side component which represents the consumer from Liu's model. In addition, the model takes into account several additional details like considering both clients' conventional and fair use requests.

The model applied in WMRM [9] is also compatible with the Liu's model. The main difference is the distributor component that was replaced with two modules: Web Server and Streaming Media Server.

B. FOAFRealm Data Dictionary

The use of ODRL as an REL for our purposes requires an additional Data Dictionary to avail of the information controlled withing FOAFRealm. In order to properly express constraints on content based on relationships between users and their friendship level, we are providing an example Data Dictionary for FOAFRealm. The use of friendshipLevel represents xoaf:frienshipLevel (trust level in friend), distance represents xfoaf:distance (friends distance from agent), and mbox represents the URI foaf:mbox from the foaf:Agent domain. All detailed XML schemas from this section are described in the appendix (See section X)

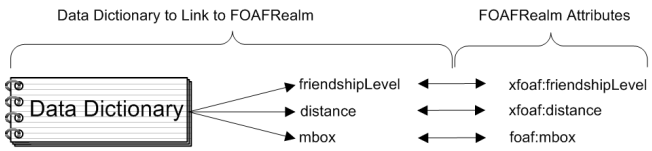

Fig. 3. FOAFRealm Data Dictionary

B.1 Example 1 - eBook Offer.

An elearning vendor wishes to offer their "Learning Spanish" publication for purchase (EUR29.99) for a one year use agreement. This agreement permits access and the ability to lend the ebook to a FOAFRealm friend with a friendship level of greater than 80, but this must be done with a distance between users of no greater than 2. Lending can be done for up to 90 days during the valid accessible time period. In this scenario,

we use *xf-friendshipLevel* and *xf-distance* to advertise the vendors' restriction on lending. The example is depicted on figure 4 and the vendor's offer looks like follow:

eBook Offer

Title: "Learning Spanish"
Cost: 29.99
Access Restrictions:
- Access for one year from date of purchase
- Permitted to lend eBook with restrictions
  - Require friendshipLevel > 80
  - Require maximum distance <= 20
  - Maximum lend term of 90 days
- Downstream Permission Restrictions Apply
  - Read access for 90 days from date of lend
  - No authorization to lend

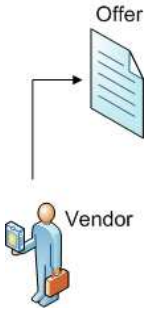

Fig. 4. Example 1 - eBook Offer

B.2 Example 2 - Agreement for ebook.

As the offer from the vendor in *Example 1* is acceptable to Dave, he chooses to purchase the book. This agreement is a representation of the agreed offer between the vendor and Dave for a purchase made 1 January 2007 at 12:00 PM. Dave is referenced in context by his *xf-mbox* identification. We have ilustrated the example on figure 5. The described agreement looks like follow:

Original Agreement

Title: "Learning Spanish"
Issue Date: 1 January 2007 @ 12:00 PM
Amount Paid: 29.99
Party: xf-dd:mbox=1234567
Access Restrictions:
- Access Expires: 365 Days from issue
- Permitted to lend eBook with restrictions
  - Require friendshipLevel > 80
  - Require maximum distance <= 20
  - Maximum lend term of 90 days
- Downstream Permission Restrictions Apply
  - Read access for 90 days from date of lend
  - No authorization to lend

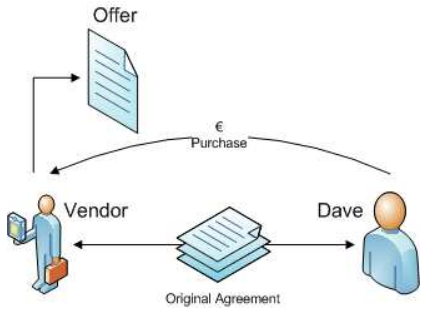

Fig. 5. Example 2 - Agreement for ebook

B.3 Example 3 - New agreement for ebook - Lending.

As Dave has finished working with the Spanish book for the time being, he chooses to lend it to Kate. A new agreement must be established for Kate to use the book made on 1 March 2007 at 12:00 PM. The downstream permissions for Kate are different than for Dave due to constraints in place. This includes the restriction that Kate may use the book for an allotted amount of time, but she can not lend it to anyone else. Kate is referenced in context by her *xf-mbox* identification. The situation is illustrated on figure 6 and the new agreement looks like follow:

New Agreement

Title: "Learning Spanish"
Issue Date: 1 March 2007 12:00 PM
Party: xf-dd:mbox=2453784
FOAFRealm Details
- Relation to xf-dd:mbox=1234567
  - xf-dd:friendshipLevel > 80
  - xf-dd:distance <= 20

- Access Restrictions
- Access Expires: 90 Days
- Not Permitted to lend eBook

See figure 6 for details.

C. Architecture

To describe a prototype we use the typical 4-components based architecture [27] that is depicted in figure 7.

The proposed language extension is placed within the the Clearinghouse (License server) component. In the proposed architecture it has been enriched with a social networks module based on FOAFRealm[6], [26], [23]; The system manages FOAF profiles and enables its users to manage their social relationships (See section II); the management covers specifying trust levels and relationships. In addition to the typical architecture, the component is able to process extra social constraints written in the description of the digital content (See section B). This functionality enables the consumers to transfer copy-rights to somebody else; the transfer details are dependent on license agreements. The licenses allow content distributors to specify various details about sharing content with user's acquaintances. This information includes maximal social

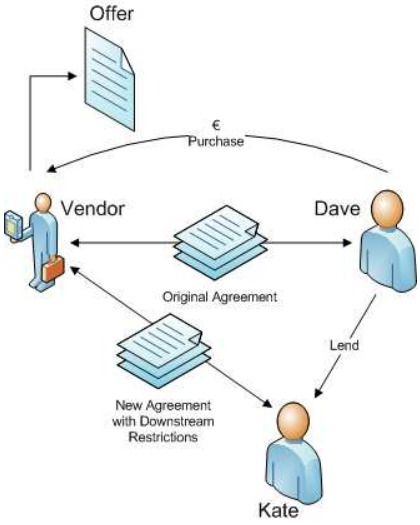

Fig. 6. Example 3 - New agreement for ebook - Lending

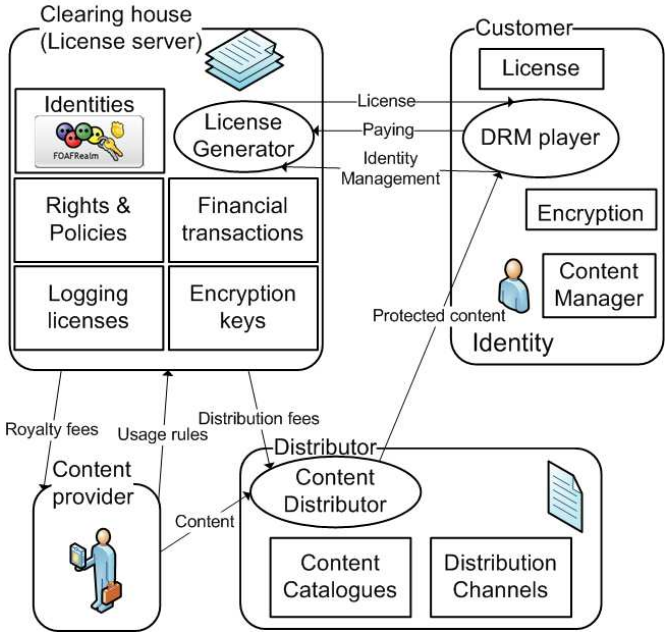

Fig. 7. A typical-DRM architecture extended with FOAFRealm module

distance between them, required trust levels, and acquaintances' social roles [17].

The role of most components remain the same. The distributor component is responsible for selling the provided content. The content provider component has been extended with virtual locking and unlocking algorithms that are necessary when lending resources by DRM. The component is also responsible for providing usage rules that uses the extra constraints (See section B). The consumer component functionality is now extended with ability to transfer copy-rights to other consumers; however, one customer at the time is allowed to use the once-bought content.

In the proposed approach, the information about acquaintance, trust levels, and relationships types is provided by users to the license server. Once the user's data is delivered, it must be signed and securely stored. In order to avoid manipulations, the frequency of changing the friends list should be limited. All copy-right transfers must be done by means of the license server which it is responsible for updating the profiles information. The licenses allow content distributors to specify various details about sharing constraints as well as typical constraints that are delivered by ODRL specification [24].

It is worth mentioning that all current DRM solutions cause privacy problems because they require users' identities to work. This problem, however, requires law adjustments otherwise it will remain [18] and it is beyond the scope of this paper.

VI. Evaluation

Apple incorporates FairPlay, built on QuickTime technology, to enforce constraints on its distributed media. The iPod and iTunes are used to play these files as trusted devices. FairPlay digitally encrypts the open standard AAC file format to produce a media file that prevents unauthorized use. The technology, originally created by Veridisc, has been circumvented by anti-DRM advocates in the form of applications such as 'FairPlay' which provide a mechanism by which to remove the encryption from your owned AAC files permitting access to the media on previously deemed unauthorized devices. While this is helpful for those wishing to use other personal devices, it still does not facilitate authorized sharing among friends. FairPlay restricts access to personal devices, nominated computers, and CD burning (customers do not retain first sale right). While the encrypted file can be transported between friends, the license to decrypt the file can not, preventing the desired sharing capability as proposed in our example using ODRL.

Microsoft has accepted the need for interoperability and has taken steps in this direction by using XrML to encode various rights licenses and certificates, but issues related to patent rights and other intellectual property may pose obstacles to global interoperability. Windows WMRM utilizes license files to facilitate access to restricted media. The digital media is packaged and distributed requiring a consumer to obtain a license key to unpack and use the file. The license contains the key necessary to unlock the file, but also contains rights information that details the constraints under which the file can be used. The license will contain restrictions such as the devices that can access the file but allows transferability to other owned devices and export to other media like burning music to a CD if so stated in the license. There is a restriction on transfer of the license to other consumers, requiring each individual to acquire their own license to access the file. This poses an obstacle to the sharing of files with trusted friends by mandating that each user check in, where our proposal provides for the use of downstream rights transfer included in the ODRL specification.

IBM's EMMS is a flexible set of components that can be variably integrated to form a complete DRM solution that

best meets the implementers' requirements. The components include: 1) Content Preparation, 2) Content Mastering, 3) Web Commerce Enabler, 4) Clearinghouse Program, 5) Content Hosting Service, 6) Multi-device Server, and 7) Client Software Development Kit (SDK). The Content Preparation and Content Mastering would be the most closely related to achieving the objectives we have set forth for ODRL. These include the constraints under which the content can be distributed and usage rights. The limitations with using EMMS include the requirement for an EMMS player or software developed using the EMMS SDK. While there is opportunity to use other players, there are further restrictions such as prevention of CD burning and file transfer. The lack of interoperability offerings also falls short of our proposed use of ODRL.

VII. Related Work

A. Social Networks

A.1 Orkut

Orkut [12] (See section B) uses a simple DRM system based on social networks to protect parts of users' profiles from people they have not established strong relationship so far. There is also a notion of friends of friends type of relationship, which users can use to restrict access to parts of their profile.

A.2 Flickr

Flickr [3] is an online photo sharing community site, now part of Yahoo suite. It offers users a simple DRM model to protect their photos from a general community. The model allows to annotate relationships between users as friendship or family relationship, or both. Therefore, two subnetworks of social relationships are maintained: a network of friendship relationships and a network of family relationships. A user is allowed to restrict access to his/her photos using friendship or family network, or both.

B. Rights Expression Languages

Networked Environment for Media Orchestration (NEMO) is also a developing standard in the same market, while some competing standards emerging from groups like Sun Labs with their DReaM-MMI aiming to introduce an alternative to REL. Adobe (LifeCycle Policy Server) and Apple (FairPlay) also include REL, but maintain proprietary implementations at this time. McKinley[28] and Barlas [16] provide an introduction into the development of DRM with XML and REL, and the current marketplace for such technologies. The work discussed here will focus on the REL standards developments of XrML and ODRL, both of which are defined using XML Schema recommendations from W3C.

XrML development is based on work by ContentGuard (formerly a Xerox technology) and has evolved on two paths: 1) v1.2 adopted by Microsoft and incorporated into the Windows Rights Management Services; and 2) v2.0 adopted by Moving Picture Experts Group (MPEG) and finalized into and ISO standard (ISO MPEG REL) as part of the MPEG-21 framework on standards for digital media. The ISO MPEG REL is a data model composed of four entities and their associated relationship using the basic assertion 'grant'. The entities are: 1) the pricipal to whom the grant is issued; 2) the right that the grant specifies; 3) the resource to which the grant applies; and 4) the condition that must be met before the right can be exercised.

VIII. Conclusions and Future Work

Fair use, based on the physical availability of an item has in the past helped to keep copyright infringements to a minimum, but the idea can no longer be applied where electronically transferable media is concerned.

Although some critics claim that the problem cannot be solved because of its very nature, the proposed ideas attempt to find a compromise that will be acceptable to both consumers and companies.

The main problem is that a precise algorithm that decides when a use is fair does not exist. Furthermore, the fair use definition will require that future work be conducted by legislators to solve its international ambiguities. Therefore, it is "AI-hard problem" [22] and without highly sophisticated intelligence we are not able to solve it. In most cases proper policy interpretation requires human interaction. Only those policies that can be narrowed to yes/no decision can be automated successfully.

Using social networks does not provide a solution either, although it does attempt to make it more consumer friendly whilst leaving enough control for content distributors. Additionally, exceptions in interpretations happen and depend on the consumer's intentions and environment.

In the future, we will explore the idea within Fair Rights Management [2] (FRM) project. Continuing this research, we will take into consideration roles and relationships based networks within DRM systems. Future development will be targeted at e-Learning environments. Moreover, we will deploy the prototype within existing systems. Finally, we will investigate some related aspects of the law.

IX. Acknowledgments

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Sławomir Grzonkowski is a researcher and a director of the DRM lab in eLearning Cluster in DERI Galway. His research is related to the Semantic Web, e-Learning, security, Peer-to-Peer networks, distributed systems, social networks, and trust. Currently, he is involved in work on a digital identity based on a social network. He is an active member of Corrib.org (FOAF-Realm, JeromeDL) cluster project. Co-founder of hypercup.org project and a founder of Fair Rights Management [2] project.

Brian D. Ensor is a Ph.D. student in the Graduate School of Computer and Information Sciences at Nova Southeastern University, Head of Technical Services for Digital Enterprise Research Institute, Galway, and Head of Projects for the National University of Ireland, Galway. His current research interests include privacy enhancement and user centric control within identity management.

Sebastian Ryszard Kruk is a researcher and a director of the Semantic Infrastructure lab in the eLearning Cluster in DERI, NUI, Galway, and the project leader of Corrib.org affiliated with Gdansk University of Technology. His research is related to the Semantic Web, digital libraries, information retrieval, security, distributed computing and e-learning.Through his projects: JeromeDL, FOAFRealm and MarcOnt, he realizes a vision of semantic digital libraries. He manages a number of other open source projects.

Adam Gzella is a PhD Researcher at Digital Enterprise Research Institute, National University of Ireland, Galway, Ireland. He is a member of the eLearning Cluster. His research is related to the Semantic Web, e-Learning, security, Peer-to-Peer networks, distributed systems, social networks, and trust.

Stefan Decker is a professor at the National University of Ireland, Galway, director of the Digital Enterprise Research Institute and Cluster Leader of the Semantic Web Cluster within the institute. Previously he worked at ISI, University of Southern California (2 years, Research Assistent Professor and Computer Scientist), Stanford University, Computer Science Department (Database Group) (3 Years, Post-Doc and Research Associate), and Institute AIFB, University of Karlsruhe (4 years, PhD Student and Junior Researcher).

Bill McDaniel is leading the eLearning research cluster at DERI, the Digital Enterprise Research Institute at the National University of Ireland at Galway. He has founded and owned several companies including 2 software firms, a consulting company, a recording studio, a publisher, and the first internet cafe in North Texas. He has been a CTO of 5 firms and prior to joining DERI was a Senior Scientist II at Adobe Systems in San Jose, CA.

X. Appendix

A. FOAFRealm Notion

FOAFRealm introduces a special notion for describing access rights to resources (Kruk, 2004). For example, a restriction that grants access to people who are within 3 degrees of separation from the user slawomir.grzonkowski@deri.org and whose trust level computed across the social network is above 50% is encoded in FOAFRealm as F[mailto:slawomir.grzonkowski@deri.org]3,5, where 3 stands for 3 degrees of separation and ; 5 represents the 50% minimal trust level.

B. XML Schema

The following is an XML Schema with appropriate namespace defined.

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:schema targetNamespace="http://example.com/XFOAF-DD"
        xmlns:xsd="http://www.w3.org/2001/XMLSchema"
        xmlns:o-dd="http://ordl.net/1.1/ODRL-EX"
        xmlns:xf-dd="http://example.com/XFOAF-DD"
        elementFormDefault="qualified"
        attributeFormDefault="qualified">
    <xsd:import namespace="http://odrl.net/1.1/ODRL-EX"
            schemaLocation="http://odrl.net/1.1/ODRL-EX-11.xsd"/>
    <xsd:element name="friendshipLevel" type="contentType"
            substitutionGroup="o-ex:contextElement"/>
    <xsd:element name="distance" type="contentType"
            substitutionGroup="o-ex:contentElement"/>
    <xsd:element name="mbox" type="contextType"
            substitutionGroup="o-ex:contextElement"/>
</xsd:schema>
```

C. Example 1 - eBook Offer.

An elearning vendor wishes to offer their "Learning Spanish" publication for purchase (EUR29.99) for a one year use agreement. This agreement permits access and the ability to lend the ebook to a FOAFRealm friend with a friendship level of greater than 80, but this must be done with a distance between users of no greater than 2. Lending can be done for up to 90 days during the valid accessible time period. In this scenario, we use xf-friendshipLevel and xf-distance to advertise the vendors' restriction on lending.

XML Representation of offer:

```
<?xml version="1.0" encoding="UTF-8"?>
    <o-ex:rights xmlns:o-ex="http://odrl.net/1.1/ODRL-EX"
        xmlns:o-dd="http://odrl.net/1.1/ODRL-DD"
        xmlns:xf-dd="http://example.com/XFOAF-DD">
    <o-ex:offer>
        <o-ex:asset>
            <o-ex:context>
                <o-dd:uid>uri:example.net/ebooks/author12345
                </o-dd:uid>
                <o-dd:name>Learning Spanish</o-dd:name>
            </o-ex:context>
        </o-ex:asset>
        <o-ex:permission>
            <o-ex:requirement>
                <o-dd:prepay>
                    <o-dd:payment>
                        <o-dd:amount o-dd:currency="EUR">
                        29.99</o-dd:amount>
                    </o-dd:payment>
                </o-dd:prepay>
            </o-ex:requirement>
            <o-dd:display>
                <o-ex:constraint>
                <o-dd:accumulated>P365D</o-dd:accumulated>
                </o-ex:constraint>
            </o-dd:display>
            <o-dd:lend>
                <o-ex:constraint>
                    <o-dd:accumulated>P90D</o-dd:accumulated>
                    <xf-dd:friendshipLevel>80
                    </xf-dd:friendshipLevel>
                    <xf-dd:distance>2</xf-dd:distance>
                    <o-dd:transferPerm downstream="less">
                        <o-dd:display>
                            <o-ex:constraint>
                                <o-dd:accumulated>P90D
                                </o-dd:accumulated>
                            </o-ex:constraint>
                        </o-dd:display>
                    </o-dd:transferPerm>
                </o-ex:constraint>
            </o-dd:lend>
        </o-ex:permission>
    </o-ex:offer>
</o-ex:rights>
```

D. Example 2 - Agreement for ebook.

As the offer from the vendor in Example 1 is acceptable to Dave, he chooses to purchase the book. This agreement is a representation of the agreed offer between the vendor and Dave for a purchase made 1 January 2007 at 12:00 PM. Dave is referenced in context by his xf-mbox identification.

XML Representation of agreement:

```
<?xml version="1.0" encoding="UTF-8"?>
<o-ex:rights xmlns:o-ex="http://odrl.net/1.1/ODRL-EX"
        xmlns:o-dd="http://odrl.net/1.1/ODRL-DD"
        xmlns:xf-dd="http://example.com/FOAFRealm-DD">
    <o-ex:agreement>
        <o-ex:context>
            <o-dd:uid>urn:example.net/ebooks/vendorid/12345
            </o-dd:uid>
        </o-ex:context>
        <o-ex:asset>
            <o-ex:context>
                <o-dd:uid>uri:example.net/ebooks/author12345
                </o-dd:uid>
                <o-dd:name>Learning Spanish</o-dd:name>
                <o-dd:date>
                    <o-dd:fixed>2007-01-01T12:00:00</o-dd:fixed>
                <o-dd:date>
                <o-dd:event>issue</o-dd:event>
            </o-ex:context>
        </o-ex:asset>
        <o-ex:permission>
            <o-ex:requirement>
                <o-dd:prepay>
                    <o-dd:payment>
                        <o-dd:amount o-dd:currency="EUR">29.99
                        </o-dd:amount>
                    </o-dd:payment>
                </o-dd:prepay>
            </o-ex:requirement>
            <o-dd:display>
                <o-ex:constraint>
                    <o-dd:accumulated>P365D</o-dd:accumulated>
                </o-ex:constraint>
            </o-dd:display>
            <o-dd:lend>
                <o-ex:constraint>
                    <o-dd:accumulated>P90D</o-dd:accumulated>
                    <xf-dd:friendshipLevel>80</xf-dd:friendshipLevel>
                    <xf-dd:distance>2</xf-dd:distance>
                    <o-dd:transferPerm downstream="less">
                        <o-dd:display>
                            <o-ex:constraint>
                                <o-dd:accumulated>P90D
                                </o-dd:accumulated>
                            </o-ex:constraint>
                        </o-dd:display>
                    </o-dd:transferPerm>
                </o-ex:constraint>
            </o-dd:lend>
        <o-ex:permission>
        <o-ex:party>
            <o-ex:content>
                <xf-dd:mbox>1234567</xf-dd:mbox>
            </o-ex:content>
        </o-ex:party>
    </o-ex:agreement>
</o-ex:rights>
```

E. Example 3 - New agreement for ebook - Lending.

As Dave has finished working with the Spanish book for the time being, he chooses to lend it to Kate. A new agreement must be established for Kate to use the book made on 1 March 2007 at 12:00 PM. The downstream permissions for Kate are different than for Dave due to constraints in place. This includes the restriction that Kate may use the book for an allotted amount of time, but she can not lend it to anyone else. Kate is referenced in context by her xf-mbox identification.

XML Representation of agreement:

```
<?xml version="1.0" encoding="UTF-8"?>
<o-ex:rights xmlns:o-ex="http://odrl.net/1.1/ODRL-EX"
        xmlns:o-dd="http://odrl.net/1.1/ODRL-DD"
        xmlns:xf-dd="http://example.com/FOAFRealm-DD">
    <o-ex:agreement>
        <o-ex:context>
```

```
            <o-dd:uid>urn:example.net/ebooks/vendorid/12345
            </o-dd:uid>
            <o-dd:date>
                <o-dd:fixed>2007-03-01T12:00:00</o-dd:fixed>
            <o-dd:date>
            <o-dd:event¿issue</o-dd:event>
        </o-ex:context>
        <o-ex:asset>
            <o-ex:context>
                <o-dd:uid>uri:example.net/ebooks/author12345
                </o-dd:uid>
                <o-dd:name>Learning Spanish</o-dd:name>
            </o-ex:context>
        </o-ex:asset>
        <o-ex:permission>
            <o-dd:display>
                <o-ex:constraint>
                    <o-dd:accumulated>P90D</o-dd:accumulated>
                </o-ex:constraint>
            </o-dd:display>
        </o-ex:permission>
        <o-ex:party>
            <o-ex:content>
                <xf-dd:mbox>2453784</xf-dd:mbox>
            </o-ex:content>
        </o-ex:party>
    </o-ex:agreement>
</o-ex:rights>
```