Multimedia Content Distribution Governed by Ontology-Represented Contracts

Víctor Rodríguez, Jaime Delgado

DMAG Distributed Multimedia Applications Group
Universitat Politècnica de Catalunya, Jordi Girona, 1-3, 08034 Barcelona, Spain
Universitat Pompeu Fabra, Passeig de Circumval•lació, 8, 08003 Barcelona, Spain
victor.rodriguezd@upf.edu, jaime.delgado@ac.upc.edu

Abstract. Multimedia content can be digitally distributed in a B2B and in a B2C context. While B2C distribution has been successfully governed by means of digital licenses, B2B transfers have received less attention. These digital licenses have been expressed in standard RELs (Rights Expression Language) and they can be seen as the electronic replacement of distribution contracts and end user licenses. However RELs fail to replace the rest of the contracts agreed along the complete Intellectual Property (IP) Value Chain. To represent their corresponding electronic counterpart licenses, an IP value chain ontology able to represent contract terms is presented here. It has been conceived to deal with a broader set of parties, to handle typical clauses found in the audiovisual market contracts, and to govern every transaction performed on IP Objects. Contract clauses are modelled as deontic logic propositions, and an event-based system is described to allow a DRM system the execution of the contract.

Keywords. Contract, license, DRM, Intellectual Property, Ontology, MPEG-21, REL, ODRL, Semantic Web.

1. Introduction

DRM (Digital Rights Management) systems for the distribution of multimedia content have been present since the last decade. On despite of the controversy arisen around its mere existence, DRM systems have preserved the concept of Intellectual Property of artistic creations in its digital format.

Consumers have been reluctant, though, to accept the restrictions imposed by these DRM systems, and generally no crime has been perceived in the fact of consuming at no price music downloaded from P2P networks, the major alternative distribution channel to legal B2C trade.

DRM systems for distribution of multimedia contents to the end user have not been a big social hit then, but at least they have proved to be a technological success. Technology had failed to prevent illegal copies, but at least has succeeded at providing channels for a fair trade under the form of DRM systems.

But Intellectual Property Objects are object of trade not only for the final consumer. From the very original idea in an author´s mind until the final product,

there have been some other intermediate IP objects along this process (that we call *value chain*), and they are subject of a possible trade too. We are speaking about rights on compositions, concerts, editions, arrangements etc. In this B2B sector the regulations and agreements have remained largely up to date in the analogue world. These contracts include author contracts, performance contracts, synchronization contracts and edition contracts among others.

For the case of B2B commerce of multimedia content, the need for controlled trade under the terms of the law has been undisputed, but the technologies have not been extensively enough deployed. When multimedia material is purchased not for venial leisure time but for business, formal written contracts are offered, agreed and observed. These contracts are paper contracts (often referred as *narrative* contracts) and are signed personally. The economic flow in each transaction does not consist of a few Euros, but of important amounts of money, and narrative contracts are not substituted at all by digital licenses.

Lack of trust on electronic transactions is not the only reason explaining the disappointing spread of DRM systems in the B2B transactions of multimedia material. We could find the reasons in a lack of interoperability among the systems, and above all, in the insufficient scope of current RELs.

It is a thesis of this paper that current RELs are not expressive enough to model the agreements arranged along the Intellectual Property Value Chain, and it is its aim to propose a new more expressive representation.

This representation will comprise an ontology, its mechanisms to express contract clauses (either obligations, permissions or bans) and the rule logic determining which actions to take after each transaction.

2. Overview of electronic contracts formats

This section reviews the existing electronic contract formats and studies their ability to govern a DRM system.

2.1 Passive and active contracts

We understand by *agreement* a mutual promise between two parties, and by *contract* a legally binding agreement. The terms of a contract may be expressed written or orally, implied by conduct, industry custom, and law or by a combination of these things. Or they can be digitally specified: an *electronic contract* is a contract whose representation can be understood by computers, thus allowing DRM systems to control it and execute it automatically. The mere digitalization of a text does not constitute an electronic contract alone.

Narrative contracts are *passive* in the sense that once they are signed, their prominence only arises in case of dispute. Electronic contracts in a DRM system are *active* as they play an important role in the execution of the contract.

2.2 Review of electronic formats

The earliest electronic contract representations were born together with the electronic commerce and the first Electronic Data Interchange (EDI) standards. EDI has been of huge importance in the industry, and comprises a set of standards for structuring information to be electronically exchanged between and within businesses, organizations, government entities and other groups.

COSMOS [1] was an e-commerce architecture developed in the 1996 supporting catalogue browsing, contract negotiation and contract execution. It defined a contract model in UML and proposed a CORBA-based software architecture in a quite coherent manner. It should be remarked their use of UML and its high expressivity, given that an UML specification could somehow be seen as a Computer Ontology [2], if the models had a standard representation.

DocLog [3] was an electronic contract representation language introduced in the 2000 with a `XML like' structure, which anticipated the next generation of XML-based contract representations. So when XML was mature enough, it was seen as a good container of contract clauses, and thus the new formats came under the form of a XML Schema or a DTD.

An effort to achieve a common XML contract representation was the Contract Expression Language (CEL) [4], developed by the Content Reference Forum. It formalized an XrML [5] based language that enabled machine-readable representation of typical terms found in content distribution contracts and was compliant with the Business Collaboration Framework (BCF) [6], but finally was not standardized.

The advent of the Semantic Web fit well with the contracts content, and soon contract representations evolved from the syntactic representation level to the semantic one [7][8] being developed ontologies in KIF or OWL. And still climbing levels in the Semantic Web layered model, RuleML was enacted as the new model container for electronic contracts, given that a contract declares a set of rules [9]. RuleML [10] provided a Web-oriented abstract syntax and declarative knowledge representation semantics for rules; but the concrete syntax could have the form of a RDF schema, thus providing a seamless integration with OWL ontologies. Some of these contract models have been aimed also at governing Information Technology systems [11][12][13].

However, the ultimate technology on contract representation has given a step backwards and has rejected RuleML as the contract language. We are referring to “eContracts”, the new OASIS [14] standard. In 2002 OASIS established the LegalXML eContracts Technical Committee to evaluate a possible eContracts Schema, and its first version of the standard has been approved during 2007 [15]. This seems to be the most promising format.

The model proposed in this paper does not rely either on a RuleML-based schema, but still adheres to the ontology representation. It considers that the Intellectual Property model lacks a simple model representing the universal know-how on the field, and this model has to be established first before the rules are described. Also, the models reviewed in this section were general oriented, excepting CEL, while this work is only interested on specific contracts in the multimedia content sector.

The work presented in this paper aims at representing the B2B contracts in the multimedia market, and at using this representation as the governing steer of the DRM system.

3. Analysis of real contracts in the market of multimedia material

The work done here around contracts has been based on a set of 40 real narrative contracts from the audiovisual market provided by a producers association [16], plus others to cover the whole spectrum of contracts around IP protected material. There has been also a survey of contract templates sold by law companies specialized on Intellectual Property protection, and more than 30 different contracts have been found, concerning every kind of role.

The contracts accounted an average of 8 pages, and 17 clauses each. Although clauses are representative as unit of information, a single clause sometimes represented several complex ideas, although sometimes just one idea spanned several clauses. In the simplest case, clauses are sentences, and each of them can be classified according to the deontic logic, in terms of what can be done, must be done and is forbidden. The most important clauses fit into one of these categories: *Permissible*, *Impermissible*, *Obligatory* (all of them subject to the deontic logic) or *Claims* (sentences that are considered true).

Permissible: Equivalents to '*The licensee can*'

- *Rights*. The licensee can exercise certain rights. This is usually the first and main clause.
- *Resource* The referenced resource is either mentioned in the first clause as well, or detailed as an appendix when it is a list of items.
- *Report and Auditing* In distribution contracts where benefits have to be distributed according to the sales, these sales have to be reported.

Obligatory: Equivalent to '*The licensee must*'

- *Fee* The licensee must pay a fee with the described conditions
- *Territory* The licensee must exercise the right (if he/she does) in the given location.
- *Term* The licensee must exercise the right (if he/she does) in the given time

Impermissible: Equivalent to '*The licensee must not*'

- *Confidentiality* In B2B relations there is usually a clause banning the public issue of information.

Claims: Equivalent to '*Something is*'

- *Disclaimer* To deny responsibilities on certain issues etc.
- *Jurisdiction* In case of dispute, the agreed jurisdiction and court is agreed.
- *Breach and termination* These clauses provision the end of the contract in normal or abnormal conditions.

If every contract represents an agreement between two parties who belong to the value chain, contracts can be classified according to the signing parties. Fig. 2 shows

the typical name of the contract types and relates them with the parties, including the contract between End User and Distributor (usually an oral contract).

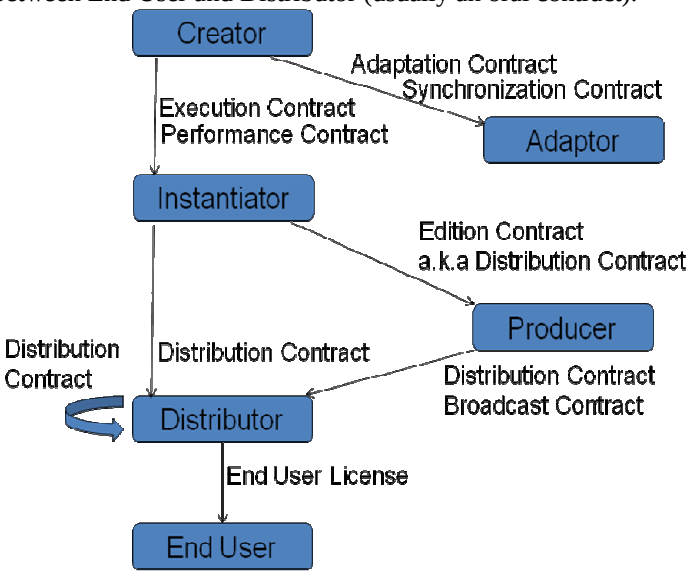

Figure 1 Most common contracts along the value chain

4. Assessment of current RELs to express narrative contracts

Considering the role that REL licenses play on DRM systems, they can be seen as effective electronic contracts that are being enforced. As such, this section will analyze how well they perform this task, and for this, the two most important RELs have been considered, namely the MPEG-21 REL [17] and the Open Digital Rights Language (ODRL) [18]. The later has additional importance considering that the Open Mobile Alliance (OMA) has developed its OMA DRM Rights Expression Language based on ODRL [19].

Both RELs were developed in the late 1990s, but none can be considered fully deployed up to this date. On July 2003, parts 5 and 6 of MPEG-21 were approved as Final Draft International Standards; they described the Rights Expression Language and the Rights Data Dictionary [20] respectively. Previously, in 2000, the first version of the ODRL had been proposed as an open standard language for expressing rights information over content (the section 3 of its definition matches the objectives of the MPEG RDD). In both cases, the incarnation of a REL expression is a XML file called *license*. This license is what we pretend to see and evaluate as an electronic contract.

In ODRL, the license pretends to express not only agreements, but also offers, what can be seen as simply potential contracts.

4.1 Contract parties in the license

Licenses refer always to two parties (actually an MPEG-21 license may content several grants each of them with a different party, but then we can consider the grant as the basic license unit). In MPEG-21 language, parties are called *issuer* and *principal*, while in ODRL they are directly referred as *parties*, classified as *end users* and *right holders.*

No more information is given about who might be these parties, excepting that they are uniquely identified, and that one of them (the rights granter) electronically signs the document. In the framework of MPEG-21, users include "individuals, consumers, communities, organizations, corporations, consortia, governments and other standards bodies and initiatives around the world" [21]. In ODRL, "parties can be humans, organizations, and defined roles". According to the standards, users are only defined by the actions they perform, but if we attend to the expressivity of both RELs, in the licenses there can be only end users and distributors (see Tables 1 and 2).

Table 1 Rights defined by MPEG-21 REL in its core and multimedia extension

Right	**Party**	**Right**	**Party**
Issue	distributor	Extract	end-user
Revoke	distributor	embed	end-user
possessproperty	end-user	play	end-user
Obtain	distributor	print	end-user
Modify	end-user	execute	end-user
Enlarge	end-user	install	end-user
Reduce	end-user	uninstall	end-user
Move	end-user	delete	end-user
Adapt	end-user		

Table 2 Permissions defined by ODRL. Transfer actions belong to distributors

Usage	**Reuse**	**Asset Management**	**Transfer**
End-user			Distributor
Display	Modify	Move	Sell
Print	Excerpt	Duplicate	Lend
Play	Annotate	Delete	Give
Execute	Aggregate	Verify	Lease
		Backup/Restore	
		Install/Uninstall	

Both MPEG-21 and REL do not characterize in depth more kind of users than End Users and Distributor but a contract model should consider all the roles appearing in Figure 1.

4.2 Rights expressed in the license

The rights defined by MPEG-21 REL and ODRL are those shown in Tables 1 and 2. They have to be compared with the real necessities detected in the analysis of the contracts performed in the previous section, and they have to be compared with the basic action defined along the IP Value Chain. The new list of actions and rights needed to express the contract information are listed in Table 3.

Table 3 Main actions and rights to be considered in a contract representation

IP Value Chain Actions	**Most common rights appeared in contracts**			
CreateWork	Reproduce	Broadcast	Adapt	Lease
Distribute	Download	Copy	Convert	License
MakeAdaptation	Upload	Print	Transcode	Promote
MakeInstance	MakeAvailable	Record	Remix	Stream
MakeManifestation	PubliclyPerform	Modify	Distribute	
Produce	Exhibit	Translate	Sell	
Use	Transmit	Dub	Advertise	

Actions and rights in Table 3 do not take into account the REL rights, and the later can be evaluated about how well they match the contract-extracted rights. The comparison shows that MPEG-21 rights and ODRL permissions do not completely represent the information expressed in the contracts, although RELs foresee mechanisms for the extension of the list.

5. IP Value Chain Ontology

XML representation of contracts, under the form of REL licenses is of limited expressivity compared to the contract ontologies presented in section 2. A first IP rights ontology, IPROnto, was presented in a former Jurix conference [22], and soon afterwards MPEG-21 RDD was also formalized as an OWL ontology, RDDOnto [23].

More recently, the authors of this work have contributed their ontology of the IP Value Chain model to the specification of the Interoperable DRM Platform (IDP) given by the Digital Media Project (DMP) [24][25], and have called to reflection about the need of a similar approach in the MPEG group [26]. Above this ontology, a Java API has been proposed [27][28], and a practical application has been implemented, in the context of the AXMEDIS [29] project [30][31].

The ontology describes the IP model with three main classes, “action”, “role” and “IP Entity”, whose relationship are shown in Figure 2.

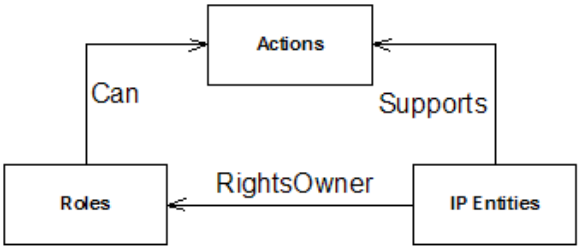

Figure 2 Three main classes and their relationships of the ontology

Table 4 shows in detail the derived classes, consisting of the main IP Entities (Work, Product etc.), the main roles (Creator, Producer etc.) and the main action, subdivided between TransformingActions (creating new IP Entities) and rights focused to the end user.

Table 4. Main classes of the ontology

Root classes	**Subclasses**
IP Entities	Work, Adaptation, Manifestation, Instance, Copy, Product
Roles	Creator, Adaptor, Instantiator, Producer, Distributor, EndUser
Actions	TransformingActions (adapt, perform, etc.), ConsumeRights (play etc)

Each of the above classes has a set of attributes describing the concept. For example, each role has a *creation date and time* attribute, a *reference code* attribute so they can be associated with external databases etc.

Relations bind concepts, and for each relation a *domain* and a *range* are defined, thus linking the IP Entities with the corresponding roles and rights. Relations are shown in Table 5.

Table 5. Ontology relations

Relation	**Domain**	**Range**
ResultsIn	TransfomingAction	IPEntity
ComesFrom	IPEntity	IPEntity
RequiresAuthorisationFrom	Action	Role
CanExercise	Role	Action
CanApply	Action	IPEntity

- *ResultsIn*. Maps *TransformingActions* into *IPEntities*, stating the resulting *IP Entity* after applying a certain transforming action. For example, there is a relation "*ResultsIn*" that binds *Adapt* (subclass of *TransformingAction*) with *Adaptation*.
- *RequiresAuthorisationFrom*. This object property maps Actions to Roles, and says for an action, which roles must authorise the execution of the right
- *ComesFrom*. Maps *IPEntities* to *IPEntities*, stating the IP Entity upon which another depends for its genesis

- *CanExercise*. States regardless of authorizations, which Actions can be performed by which roles. Not all roles can perform all actions, for example, an *EndUser* can execute the right called *play* (providing t it has permissions), but cannot make an adaptation as this is not a task proper of its role.
- *CanApply*. States which *Actions* can or cannot be applied over a given *IP Entity*. For example, a W*ork* cannot be *Played*.

6. Semantic Representation of Contracts

6.1 Expression of the contract

The ontology presented in the previous section represents a static model that is not suitable to represent a contract in a DRM system, that is to say, a license. Although it is a model of IP value chain where all the parties and all the different kinds of IP are represented, it lacks the expressivity to deal with the dynamic execution of an electronic contract in DRM systems. This section describes how to confer the required expressivity.

The starting point is the assumption that a contract is a document expressing deontic sentences around the IP model, and that these sentences are subject to the model logic and the deontic logic.

Deontic logic is defined as the field of logic that is concerned with obligation, permission and related concepts [32], essentially the topics dealt in a contract. It speaks about what is obligatory (OB), what is permissible (PE), what is impermissible (IM), what is gratuitous (GR), and what is optional (OP). Logical propositions can be written in the fashion of: PEp ↔ ~OB~p, or OPp ↔ (~OBp & ~OB~p) etc. The foundamentals of this logic can be found on [33].

The previous syntactic expressions (PE, OB, IM, GR, OP) can be reduced to only two operators: *obliged* (often represented with the symbol $\Box$) and *permissible*, (represented with the diamond $\Diamond$). With these operators, and the modal logic operators (AND $\wedge$, OR $\vee$, NOT ~), the deontic logic can be built. This has not been the only effort making a formal representation of the contracts, having a recent precedent in [34].

As an example, let´s consider the following propositions:

- w Bob MakeAvailable Song
- p Alice previews Song
- q Alice plays Song
- r Alice pays 1 euro
- s Alice is in Holland
- t Bob provides Song with a minimum of quality

Then, a very simple end user contract could be described with the following sentences:

1. PE ◇ (p) Alice may make a preview of Song
2. PE ◇ (q ∧ r ∧ s) Alice may (play the song, pay 1 euro and be in Holland)
3. OB t→ □ (t) Bob must grant Song with a minimum of quality, in case he does

The contract has been represented according to a formal logic, and syntactically as an OWL file. As OWL lacks these deontic operators, they will have to be defined as well as the minimum set of axioms of the deontic logic. With these operators and the modal logic, standard reasoners on OWL like Pellet [35] will be able to make inferences and a governing system based on instances of the ontology will be possible.

6.2 Contract execution: Events and Rules

To execute the contract, the ontology as presented in [24] is not enough because does not model *events* in the course of the contract execution. Events may trigger *rules* and possibly activate further actions by calling a service described through a service point. As in [4], the model proposed here also makes uses of Events, defined as OWL classes and including the following subcategories:

- *Execution*. A party executes a right or an action.
- *Transfer*. A party transfer rights about a certain IP Entity to the other party
- *Reporting*. A party reports information
- *Payment*. A party executes a payment
- *Service*. A party executes the service described by a reference

The happening of an event can trigger a set of actions, what can be expressed with RuleML. The events are registered in an EventLog, which together with the semantic license constitutes a complete authorization system.

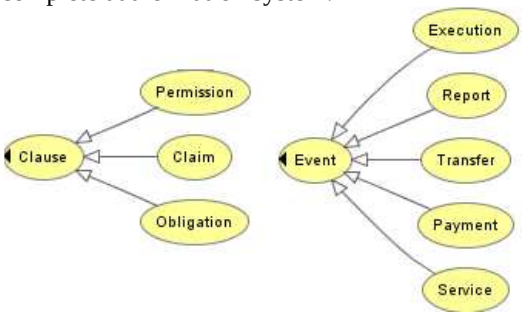

Figure 3 Classes to be added to the IP Value Chain Ontology in order to contracts to be represented and executed in a DRM system

Following the previous example, it should be codified that if Alice pays 1 euro and is in Holland, then she should have access to the Song. Formally, the rule is:

(r ∧ s) → q

And expressed with RuleML is:

```
<rulebase>
   <imp>
      <_head>
         <atom>
            <_opr href="#MakeAvailable"/>
            <var>Bob</var>
            <var>x</var>
         </atom>
      </_head>
      <_body>
         <atom>
            <_opr href="#pays"/>
            <var>x</var>
         </atom>
         <atom>
            <_opr xmlns:iso="urn:mpeg:country>iso:nl</_opr>
            <var>x</var>
         </atom>
      </_body>
   </imp>
</rulebase>
```

While facts are expressed in a similar way.

```
<rulebase>
  <facto>
    <_opr href="#pays"/>
    <ind href="#Alice"/>
  </facto>
  <facto>
    <_opr xmlns:iso="urn:mpeg:country>iso:nl</_opr>
    <ind href="#Alice"/>
  </facto>
</rulebase>
```

7 Conclusions and future work

This work acknowledged REL licenses as the governing element in DRM systems for B2C distribution of multimedia content, and declared licenses as the digital version of end user or distributor contracts. However, after an analysis of real contracts in the IP contents B2B market, it was observed that more flexibility was required to cope with the complexity of those narrative contracts.

A recently presented ontology of the IP value chain model describes the relevant kinds of IP, the main roles and the rights and actions that can be exercised. This ontology depicts the static panorama on IP objects, but is not able to describe a license governing a DRM system [36].

This work has presented an extension of such ontology able to represent contracts and to provide the reaction mechanisms in the contract execution.

If, as pointed out earlier, there is a lack of confidence on electronic B2B trade of IP objects, this paper proposes a common ontology, deontic logic based licenses, and an even driven central authorization system. If an unbiased arbiter assumed the model,

like the Authors and Interpreters Collecting Societies, this lack of trust of the Industry and the small IP providers could be overcome.

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