A Web Ontology for Copyright Contracts Management

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Abstract. Digitisation and the Internet carry new opportunities and threats to content markets, but traditional Digital Rights Management does not suffice to face them. The main problems are the lack of interoperability, the ignorance of user rights and implementation costs. Our proposal is to take copyright into account as a way to establish a common interoperability ground and means to incorporate user rights. It is based on a Semantic Web ontology that conceptualises the copyright domain. The ontology provides the building blocks for flexible machine-understandable copyright contracts and facilitates their implementation because existing Semantic Web tools can be easily reused.

1. Introduction

Traditionally, copyright management has been achieved through Digital Rights Management (DRM) systems. For instance, they have been used by record companies to protect music sold on the Internet and in enterprises in order to control content access.

DRM focuses on controlling access, the last step in the copyright value chain, and pays little attention to the previous ones: creation, derivation, recording, communication, etc. This is enough in closed domains like enterprise DRM or vertical content distribution channels.

However, traditional DRM is showing its limitations in Internet-wide scenarios, when they are forced to interoperate in open environments. Moreover, they are not expressive enough to easily accommodate the underlying copyright legal framework and the new licensing schemes that world-wide content sharing and reuse require.

Our proposal facilitates interoperation and automation, while providing a rich framework that accommodates copyright law and custom licensing schemes. It is based on a copyright ontology, which is implemented using the Description Logic variant of the Web Ontology Language. This approach facilitates implementation because existing Semantic Web tools can be easily reused.

The rest of this paper is organised as follows. First, we explore existing initiatives and related work, from DRM standardisation to formal proposals, and show their limitations. Then, our formal approach to copyright-aware DRM is presented, which is materialised in the Copyright Ontology and some extensions for copyright contracts building. Finally, its implementation based on Semantic Web tools is shown. This implementation facilitates the development of a Semantic DRM system for copyright contracts management.

2. Related Work

The DRM Watch review on DRM standards [1] shows that interoperability is a key issue for DRM systems. A very illustrative sentence from this review can be highlighted: "…consumer complaints [about DRM] have moved beyond overly restrictive DRMs to lack of interoperability among them…".

For instance, this situation arises when, in the content distribution scenario, a user wants to consume content in any of the devices she owns but DRM mechanisms prevent her from doing so. The content is tied to the device from which the purchase was performed or to whose hardware the DRM security mechanisms are associated.

2.1. DRM Standardisation

The main response to DRM interoperability requirements has been the settlement of many standardisation efforts. One of the main ones is ISO/IEC MPEG-21 [2], whose main interoperability facilitation component is the Rights Expression Language (REL) [3].

The REL is an XML schema that defines the grammar of a copyright contract building language, so it is based on a syntax formalisation approach. There is also the MPEG-21 Rights Data Dictionary (RDD) that captures the semantics of the terms employed in the REL, but it does so without defining formal semantics [4]. The other main DRM interoperability proposal is ODRL [5], which is also based on XML schemas for language formalisation.

This syntax-based approach is also common to other DRM efforts and one of main causes of the lack of production implementations also observed in the DRM Watch review. Despite the great efforts in place, the complexity of the DRM domain makes it very difficult to produce and maintain implementations based on this approach.

The implementers must build them from specifications that just formalise the grammar of the language and force the interpretation and implementation of the underlying semantics. This has been feasible for less complex domains but is hardly affordable for a complex domain like copyright, which also requires a great degree of flexibility.

Moreover, the limited expressivity of the technical solutions currently employed makes it very difficult to accommodate copyright law into DRM systems. Consequently, DRM standards follow the traditional usage control approach [6]. They concentrate their efforts in the last copyright value chain step, content consumption, and provide limited support for the other steps. For instance, the OMA[1] profile of ODRL for mobile devices governs the *play*, *display*, *execute*, *print* and *export* actions.

The limited support for copyright law is also a concern for users and has been criticised, for instance, by the Electronic Frontier Foundation [7]. The consequence of this lack is that DRM systems fail to accommodate rights reserved to the public under national copyright regimes.

In fact, just Internet publishing risks are considered and the response is to look for more restrictive and secure mechanism to avoid access control circumvention. This makes DRM even less flexible because it ties implementations to proprietary and closed hardware and software security mechanisms.

Consequently, DRM remains apart from the underlying copyright legal framework. As it has been noted, this is a risk because DRM systems might then incur into confusing legal situations. Moreover, it is also a lost opportunity because, from our point of view, ignoring copyright law is also ignoring a mechanism to achieve interoperability.

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[1] Open Mobile Alliance (OMA), http://www.openmobilealliance.org

It is true that copyright law diverges depending on local regimes but, as the World Intellectual Property Organisation[2] promotes, there is a common legal base and fruitful efforts towards a greater level of copyright law worldwide harmonisation.

2.2. Formal Approaches to DRM

In order to solve the implementation difficulties that XML-based approaches provoke, many formal methods have been proposed. Their objective is to make the underlying semantics explicit in a machine-readable form.

LicenseScript [8] is based on multiset rewriting and logic programming. Logic rules are used to model licenses and implemented using Prolog. LicenseScript provides a generic framework for licensing implementation but it lacks specific means for copyright management. It constitutes a language for access control but does not incorporate copyright notions.

These notions can be added by modelling the required logic rules, those that capture the corresponding semantics. However, this is an expensive task and very sensitive to changes because LicenseScript rules are too close to implementation issues. A more abstract representation is required and the clear candidate is ontology, the other discipline that together with logic builds up knowledge representation.

An ontology is a formal, explicit specification of a shared conceptualisation. Formal means that it is an abstract model of a portion of the world. It is an explicit specification because it is machine-readable and understandable. Shared implies that it is based on a consensus and it constitutes a conceptualisation because it is expressed in terms of concepts, properties, attributes, etc.

Additionally, at an abstract level, it is easier to define interoperability rules. They can concentrate on establishing if concepts mean the same without considering how they are written down. Consequently, there are many ontology-based initiatives. OREL [9] is an ontology that formalises MPEG-21 RDD semantics. It focuses on the RDD semantics so, a part from providing some sort of formal semantics, it inherits all the problems detected in DRM standardisation efforts.

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[2] WIPO, http://www.wipo.int

There is another ontological framework for DRM that is not based on existing rights expression languages, OntologyX[3]. However, like the previous initiatives, OntologyX concentrates on the kind of actions that can be performed on governed content and it also ignores the underlying legal framework.

3. A Semantic Web Approach to DRM

From a detailed analysis of the current situation, our conclusion is that the underlying reason for the observed problem is the lack of a flexible and expressive copyright contracts representation framework. This framework should take profit from the full potential of formal knowledge representation tools.

Such framework must deal with the underlying legal framework and, simultaneously, be easily automated in order to benefit from computerised support. The first objective is to overcome the limitations of purely syntactic approaches, like XML, and their lack of formal semantics. Therefore, our proposal is based on an ontology.

Moreover, as we want to operate through the Internet, the best choice is to use knowledge representations, and more specifically ontology languages, that can operate through this medium. The clear choice is Semantic Web ontologies based on the Web Ontology Language (OWL) standard[4], which provides a set of primitives that make possible to build web-shared conceptualisations.

The increased expressivity of web ontologies allows us to include the underlying legal framework into the formalisation and to build the rest of the system on top of it. This is a key issue because, in order to build a generic framework that facilitates interoperability, the focus must be placed on the underlying legal, commercial and technical copyright aspects.

This is the approach for the Copyright Ontology[5], detailed in the following section. The expressiveness and generality of the resulting conceptualisations allows coping with the shortcomings of existing

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[3] OntologyX, http://www.ontologyx.com
[4] Web Ontology Language, http://www.w3.org/2004/OWL
[5] Copyright Ontology, http://rhizomik.net/ontologies/copyrightonto

approaches and, additionally, it can be used as an interoperability facilitator for existing DRM standards, as it is shown in [10] for MPEG-21 an in [11] for ODRL.

Finally, the ontology is implemented as an OWL Web ontology based on the Description Logic (DL) variant, OWL-DL. This implementation facilitates contract management systems development because checking user actions against contracts and monitoring them is implemented using existing Semantic Web reasoners.

3.1. The Copyright Ontology

The copyright domain is quite complex so we face its conceptualisation in three phases. Each phase concentrates on a part of the whole domain. First, the objective is the more primitive part, the Creation Model.

Second, there is the model for the rights part, the Rights Model, and finally a model for the available actions, the Action Model, which is built on top of the two previous ones.

The Creation Model conceptualises the different forms a creation can take, which are classified depending on the three main ontological points of view [12]:

- Abstract: something that cannot exist at a particular place and time without some physical encoding or embodiment.
  - **Work**: is a distinct intellectual or artistic creation. It includes literary and artistic works, music, pictures and motion pictures, but also computer programs or compilations, like databases.
- Object: it corresponds to the class of ordinary objects and also includes digital objects.
  - **Manifestation**: the materialisation of a work in a concrete medium, a tangible or digital object.
  - **Fixation**: the materialisation of a performance in a concrete medium, a tangible or digital object.
  - **Instance**: the reproduction, i.e. copy, of a manifestation, a fixation or another instance.
- Process: something that happens and has temporal parts or stages.

– **Performance**: the expression in time of a work. Performers or technical methods might be involved in the process.
– **Communication**: the transmission of a work among places at a given time. It is a process performed when the public is not present at the place and or time where the communication originates. It includes broadcasts, i.e. one to many, but also communications from a place and at a time individually chosen.

The Rights Model follows the World Intellectual Property Organisation recommendations. It includes economic plus moral rights, as promoted by WIPO, and copyright related rights, see Fig. 1. The most relevant rights in the DRM context are economic rights as they are related to the production and commercial aspects of copyright. Reproduction, Distribution, Public Performance, Fixation, Communication and Transformation Right are the economic rights.

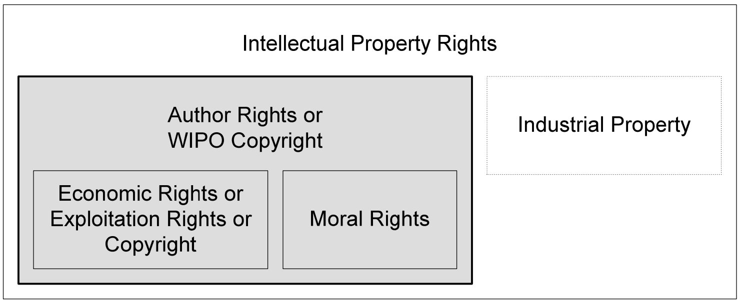

Fig. 1. The Rights Model in the Copyright Ontology

The last model, the Action Model, corresponds to the primitive actions that can be performed on the concepts defined in the Creation Model, as it is shown in Fig. 2. Actions are regulated by the rights in the Rights Model. For the economic rights, these are the governed actions:

– **Reproduction Right**: *reproduce*, commonly speaking *copy*.
– **Distribution Right**: *distribute*. More specifically *sell*, *rent* and *lend*.
– **Public Performance Right**: *perform*; it is regulated when it is a public performance and not a private one.
– **Fixation Right**: *fix*, or *record*.

– **Communication Right**: *communicate* when the subject is an object or *retransmit* when communicating a performance or previous communication, e.g. a re-broadcast. Other related actions, which depend on the intended audience, are *broadcast* or *make available*.
– **Transformation Right**: *derive*. Some specialisations are *adapt* or *translate*.

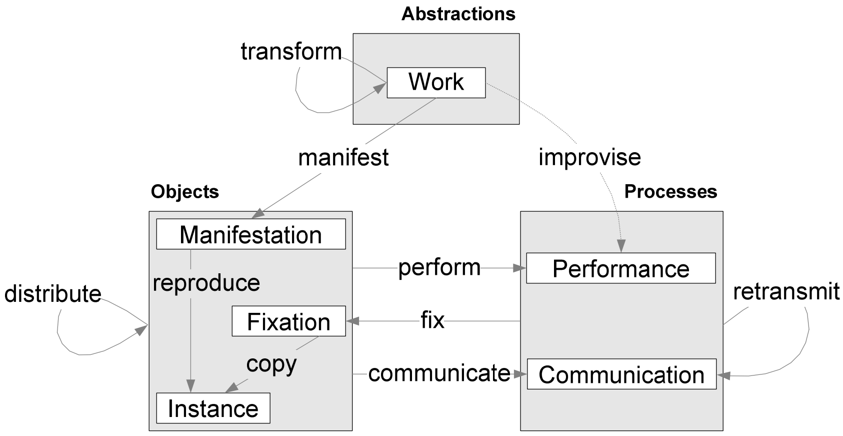

Fig. 2. Relationships between the Action and Creation Models

The action concepts are complemented with a set of relations that link them to the action participants. This set is adopted from the linguistics field and it is based on case roles [13]. The case roles are shown in Table 1.

Table 1. Case roles

	initiator	**resource**	**goal**	**essence**
Action	agent, effector	instrument	result, recipient	patient, theme
Process	agent, origin	matter	result, recipient	patient, theme
Transfer	agent, origin	instrument, medium	experiencer, recipient	theme
Spatial	origin	path	destination	location
Temporal	start	duration	completion	pointInTime
Ambient	reason	manner	aim, consequence	condition

From this point, the previously introduced pool of primitive actions and case roles can be combined in order to build the contracts that model the different value chains in the copyright domain. This flexibility is possible because these building blocks are the more primitive ones and they are backed by the underlying rights and creation models.

For instance, Fig. 3 shows how we can build a model for the value chain of serials adapted from literary works. First, the creator adapts the original literary work, e.g. Alexandre Dumas' "The Count of Monte Cristo", in order to produce a serial. The resulting adaptation is realised as a script that is performed by some actors, e.g. Gerard Depardieu, and recorded into a motion picture. This motion picture is finally broadcasted to users who can tune the resulting communication.

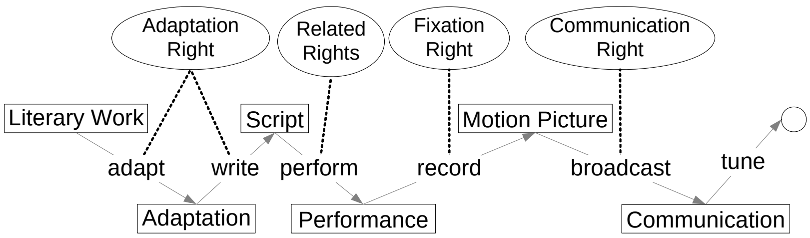

Fig. 3. Literary works adapted to serials value chain

This is just the skeleton of the value chain. In order to give a more detailed model, each step in the value chain should be modelled as an event for the corresponding action and associated participants through case roles.

However, the objective is not just to model the actual events that capture the life cycle of a given creation. Prior to these events, contracts among the involved parties are established in order to govern the value flux. Consequently, the ontology must be enriched with contract building components.

3.2. Contract Building Extensions

Copyright provides a legal framework that governs creations life cycle and tries to assure a fair compensation for all the involved parties, from authors to consumers. Copyright contracts are built on top of this legal framework and establish the terms for concrete interaction among these parties.

Contracts should capture the obligations, permissions and prohibitions that make sense in the copyright domain. The semantics of the contract terms are captured by the ontology described so far, but it lacks the terms that capture the semantics of obligations, permissions and prohibitions.

In order to produce and homogeneous and usable conceptualisation, we have incorporated this terms in the ontology using the concepts that capture the semantics of obligations, permissions and prohibitions as they appear in contracts from a natural language point of view, i.e. using the corresponding actions and case roles.

The additions are detailed next and put in relation to a generic contract modelling language, the Business Contract Language (BCL) [14,15], in order to illustrate how these additions make the Copyright Ontology a copyright contracts modelling tool. Each BCL building block is considered and related to its Copyright Ontology counterpart.

First there are BCL roles, e.g. *Purchaser*, which are captured in a generic way by the Copyright Ontology case roles. For instance, there is not a specific *Purchaser* case role but it is implicit in the *agent* case role when applied to a *Purchase* action.

BCL uses event patterns as the way to state what is obliged, permitted or prohibited by a contract; they are referenced from policies that establish their modality. They are also naturally captured by the ontology terms described so far. The proposed actions and case roles are used to model event patterns in the copyright domain.

For instance, Fig. 4 shows a pattern for all copy events in a Peer to Peer network performed by agent “granted” who copies “content01” from “PeerA” to two peers from the set “PeerB, PeerC, PeerD” at any time point six months after “2006-01-01”.

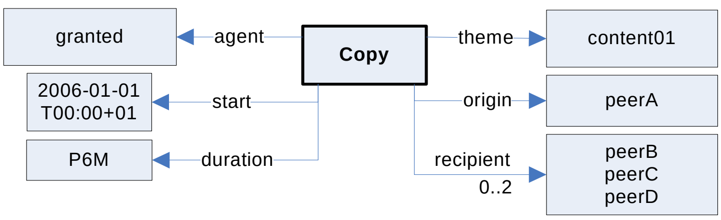

Fig. 4. Pattern for a copy action in a P2P scenario

Then, there are the terms to state the modality of these event patterns in copyright contracts. BCL defines explicitly the modalities using the Obligation, Permission and Prohibition terms. The Copyright Ontology does the same but in an implicit way, following the same “action plus case roles” approach used for event patterns.

BCL Permissions are captured by a new action, *Agree*, and the permitted pattern is linked using the *theme* case role, whose semantics are to point to the object of an action. Following with the previous example, the agreement between “granter” and “granted” in the upper part of Fig. 5 authorises the pattern pointed by the *theme* case role, the previous P2P copy pattern at the centre of the figure.

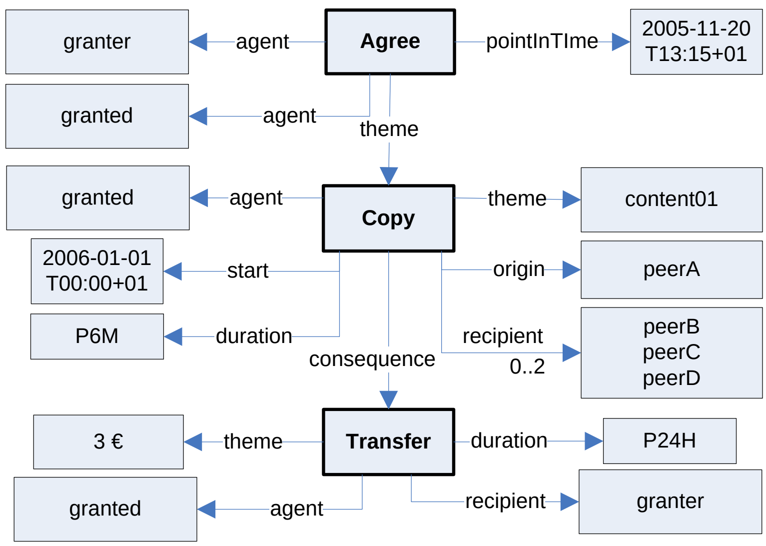

Fig. 5. Agreement that permits the P2P copy pattern whose consequence is an economic obligation

BCL Obligations are captured in the copyright contracts as event patterns that must be satisfied at some time point after the event pattern that triggers the obligation is exercised. They are modelled using the *consequence* case role that links the triggering pattern to the one that is obliged.

For instance, in the bottom part of Fig. 5 it is stated that, if the copy action is exercised, the consequence is that the “granted” agent must transfer 3 euros to the “granter” agent before 24 hours from the copy action.

BCL Prohibitions are captured by another action, *Disagree*. Like for the *Agree* action, the *theme* case role is used to link it to the object of the action, in this case to the pattern that is prohibited.

For instance, in the previous scenario, the contract might also state that it is forbidden that the "granted" agent changes "content01" using a *Disagree* pattern with the corresponding *Transform* action pattern as its *theme*.

Finally, BCL Guards are patterns that must be satisfied in order to activate the evaluation of another event pattern, thus acting as a precondition. The *condition* case role is used to model guards. It is applied to the pattern that is guarded and it links to the pattern that establishes the precondition. The approach is similar to the obligation case captured by the *consequence* case role but, in this case, the *condition* case role establishes an a priori condition.

For instance, in the P2P scenario the *Copy* pattern might by guarded by a *Transfer* one that requires that the "granted" agent makes a 1 Euro prepayment to the "granter" agent before the former can excise the permitted P2P Copy action.

4. Web Ontology Implementation

The previous conceptualisation is just an abstraction of the copyright domain and the contract building blocks. An implementation is required if we want to use it to build a computerised copyright contracts management system. The ontology has been implemented[6] using the Web Ontology Language (OWL) in order to facilitate interoperability through a web-shared ontology.

More concretely, the DL variant of OWL (OWL-DL) is chosen because, although it is constrained in order to be managed by Description Logic (DL) reasoners, such reasoners guarantee that ontologies can be put reasoned over in an efficient way. Moreover, existing tools can be used to make the implementation quite straightforward.

First of all, event patterns are implemented as OWL classes made up from the combination of existing classes, i.e. concepts in the ontology, and a set of restrictions. Restrictions are the OWL building

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[6] Copyright Ontology, http://rhizomik.net/ontologies/copyrightonto

blocks that define constraints on how members of a class, the domain, are related through a specified property to other ones, the range class. The available restrictions in OWL are:

- **allValuesFrom**: all the values for the range of the restricted property must pertain to the given class when applied to the domain class. For instance, all values of the *recipient* relation for the P2P scenario *Copy* action must pertain to the class formed by the "PeerB, PeerC and PeerD" individuals. Using DL notation this restriction: $\forall$recipient.{peerC, peerD, peerB}.
- **someValuesFrom**: there is at least one value that pertains to the given range class. The existential ($\exists$) operator is used to represent this restriction in DL notation.
- **hasValue**: the range is limited to a specific individual, not a class of them. For instance, the *theme* of the *Copy* action must be the individual "content01", in DL notation $\exists$agent.{granted}.
- **cardinality**: this restriction limits the number of individuals that can be connected through the restricted property. A maximum, minimum or exact cardinality can be defined. For instance, the *recipients* are limited to just two individuals, ($\leq$ 2 recipient).

Restrictions are combined using the intersection, union and complement logical operators in order to compose the patterns of actions. They are also combined with the classes for the restricted action in order to build the event pattern.

Table 2 shows the description of the *Copy* action pattern for the P2P scenario using DL notation. The pattern is defined as a subclass of the *Copy* class (1) and the intersection of the restrictions for the *pointInTime* case role to the time range corresponding to the six months period (2), the *agent*, *origin* and *theme* case roles to specific instances (3) and finally the *recipient* case role to no more than two (4) instances of the "PeerB, PeerC and PeerD" set (5).

Table 2. Class pattern for the actions authorised by the example license

Pattern $\sqsubseteq$	Copy	(1)
Pattern $\equiv$	$\forall$pointInTime.$\geq$ 2006-01-01T00:00:00, $\leq$ 2006-06-30T23:59:59 $\sqcap$	(2)
	$\exists$agent.{granted} $\sqcap$ $\exists$origin.{peerA} $\sqcap$ $\exists$theme.{content01} $\sqcap$	(3)
	($\leq$ 2 recipient) $\sqcap$	(4)
	$\forall$recipient.{peerC, peerD, peerB}	(5)

Once event patterns are modelled using OWL classes, DL reasoners are applied to check them. They can answer if an individual, considering its relations to other individuals and attribute values, satisfies all the restrictions of a class pattern and, thus, can be classified as an instance of that class.

In the context of the Copyright Ontology, this functionality is used to check if a particular action, modelled as an individual, is included by an event pattern. Then, depending on the context of the class pattern, the corresponding interpretation can be inferred.

If the action individual is classified into a class pattern that is the *theme* of an *Agree*, then it can be inferred that the action is permitted. However, if the pattern has a guard condition, the corresponding pattern pointed by a *condition* case role is queried in order to check that it is satisfied, i.e. there is any instance classified in the corresponding class.

It is also checked that the permitted action, despite it is agreed, is not prohibited. An action is prohibited if it is classified in the pattern pointed by the *theme* of a *Disagree*. This additional check is required because we use this behaviour to model revocation and to avoid the open world assumption (OWA) inherent to DL reasoners. More details about OWA are available from [16].

Finally, obligations are also monitored using DL reasoners. It is checked if, before surpassing the time range available for satisfying the obligation, the pattern pointed by *consequence* case roles is satisfied. This corresponds to detecting an instance that is classified in the corresponding case role. Otherwise, the obligation has been violated.

The previous interpretations of the classification of instances into classes allow implementing the semantics of the copyright contracts building blocks. However, DL reasoners can just implement event pattern checking. This corresponds to the ground level of the implementation, which must include a metalevel. This metalevel is responsible for pattern checking interpretation in order to permit or prohibit actions and detect obligation violations. Therefore, there is a ground level for the pattern checking process, the more computationally intensive part, separated from the subsequent interpretations in terms of deontic operators.

This way, our implementation of a copyrights contracts management system for Semantic DRMS[7] can benefit from the computational properties of DL reasoners. On the other hand, the limited usage patterns of the deontic operators makes it possible to implement the metalevel procedurally, as it is the case in the current version of the Semantic DRMS, in a very efficient way.

When the expressivity of OWL-DL is not enough, Semantic Web rules [17] can be combined with OWL-DL expressions in order to get increased expressivity. This is particularly useful when named variables are needed because OWL-DL does not provide them. The following section presents an example of such a use.

4.1. Traditional Rights and Usages Example

This section illustrates how the Copyright Ontology can be used to model aspects of copyright that are ignored by most DRM implementations due to the limitations of the rights expression languages they use. Moreover, it is shown that the implementation is quite straightforward.

These particular copyright aspects are called Traditional Rights and Usages (TRU) by the Digital Media Project initiative, which provides a detailed list of them at [18]. The objective of this list is to keep track of them in order to check that they can be enjoyed also in the digital space. However, no particular way to integrate them into the specifications and tools this project is currently generating is provided.

In this example, TRU number 2 is considered, it is known as private copy in civil law countries, while common law countries do not handle it specifically and consider it as part of fair use prerogatives (USA), or fair dealing and other exceptions for private study or research (UK).

The modelling effort concentrates on the private copy right, which corresponds to a part of fair use and is being promoted by WIPO copyright treaties for worldwide adoption [19]. The objective is to allow certain acts that pertain to exclusive right of reproduction without requesting prior authorization, though some kind of compensation through levies might take place, e.g. on blank media.

[7] Semantic DRM System, http://rhizomik.net/semdrms

Basically, all copy actions performed by any person on any content instance that have as a result a replica instance and whose aim is private should be allowed. The corresponding model is shown in the upper part of Fig. 6. The *private* term is modelled as the value of the *aim* case role.

In order to detail further this key aspect, there is also an agreement on any use of the resulting instance by any agent directly related to the person that produced the private copy, which is shown in the bottom part of Fig. 6. Any other use by any person not directly related is not allowed if it is not explicitly granted.

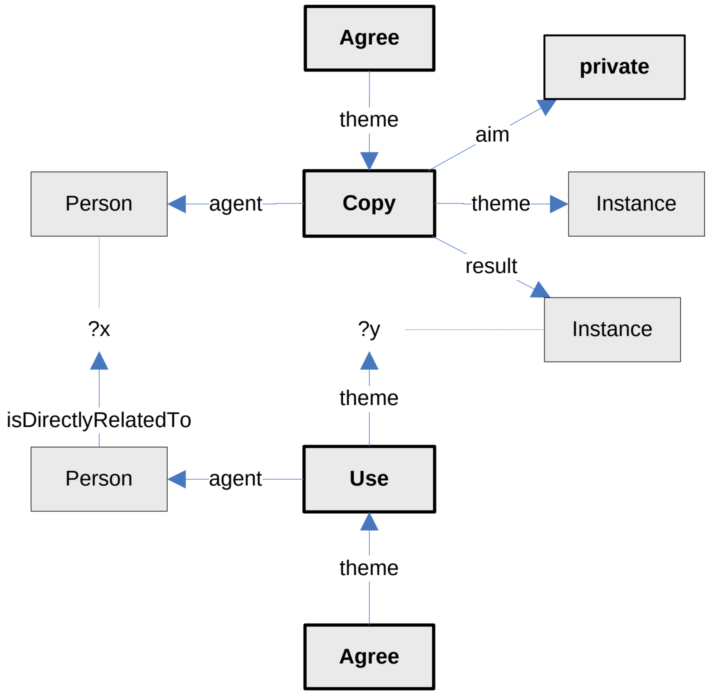

Fig. 6. Model for the “Private Copy Right”

Two things must be highlighted about the second agreement. First, the *isDirectlyRelatedTo* relation is used as a way to model direct relations among people and tries to capture the private essence, e.g. family, friends, etc. Second, the variables “?x” and “?y” are used in order to state that the relation must hold to the same person that performed the copy and to the same resulting instance.

Named variables are not available in OWL-DL so they are captured by Semantic Web rules. In this case, a rule is in charge of generating the event pattern and the second agreement using the copy pattern as input. Whenever an action is classified as an instance of the copy pattern, the rule is triggered and it asserts the agreement with the event pattern class for the concrete person and instance.

Fig. 7 shows how the action checking works for the private copy permission. The event pattern appears as a subset of the general Copy class because it is build from the intersection of Copy and the other restrictions. A particular copy action is shown and as it states that its aim is private and that it is performed by a person on an instance producing another instance, it is classified inside the previous event pattern. The pattern is the theme of an *Agree*, as shown in Fig. 6, consequently the action is granted.

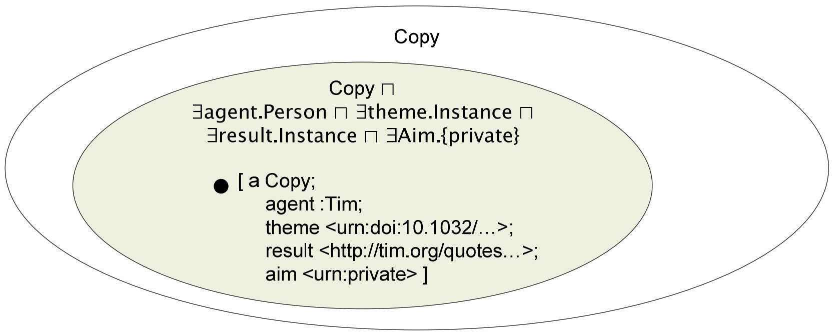

Fig. 7. Implementation of the Private Copy TRU using classes (ovals) and an instance (dot)

The previous event pattern matching also triggers a rule that assert the event pattern that grants people directly related to the replica creator to use it. Consequently, from this moment, any use that is classified into the class corresponding to the pattern will be granted.

To conclude, it is important to note that the ontology focuses on modelling the TRU, not on enforcing it. In fact, the ontology might be also used to support DRM systems based on accountability. The previous actions are just annotated and they are legal as long as there is not any counter evidence.

For instance, it is discovered that the person using the copy is in fact not directly related to the replica maker. Consequently, the DL reasoner will detect an inconsistency because the class of persons directly related to another one is disjoint with the class of persons that are not directly related to this same person.

However, if enforcing is in place, the private use part of the model, an more specifically the *isDirectlyRelatedTo* relation, can be enforced, for instance using some sort of device domains and encryptions measures like in OMA DRM [20].

5. Conclusions and Future Work

Traditional Digital Rights Management is being challenged by the new requirements posed by Internet-wide content markets and the heterogeneity of end-user devices. Current approaches are based on XML languages for content access control that find great difficulties when forced to interoperate and ignore the underlying copyright aspects.

Our approach is to see the copyright legal framework as a common ground for interoperability. However, more expressive formal methods are required in order to capture its complexity. Ontologies allow formalising legal aspects and the resulting Copyright Ontology provides the building blocks for copyright contracts modelling.

Contracts are based on event patterns, which are naturally captured by the ontology because it is based on an “action plus case roles” modelling approach. The patterns are then qualified as permitted, prohibited or obliged using some additional ontology terms.

Finally, the Description Logic variant of the Web Ontology Language (OWL-DL) is used to implement the ontology. This choice allows implementing copyright contracts in an efficient and quite straightforward way using existing DL reasoners. They are used to implement event patterns checking as classification of instances into classes. When an instance is classified into a class, it is interpreted depending on the context as a permitted, prohibited or obliged action.

This interpretation is currently implemented procedurally. However, our future plan is to model it using Semantic Web rules. Rules will also facilitate incorporating penalties into the system, i.e. obligations that take place when obligations are violated [21]. Currently, obligations are just monitored in order to detect violations.

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