Brokerage of Intellectual Property Rights in the Semantic Web

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Abstract. New approaches in the Web environment are underway. These new methodologies try to leverage it from an information medium to a knowledgeable level, from a machine point of view. This upgrade, mainly focused on improving Web automation capabilities, can solve some of the problems derived from its widespread adoption. Among them, the necessity of a framework to manage the enormous market of digitalised multimedia and to ensure that all the intervening actors get a satisfactory experience from the Internet adventure. An application under development is described and future plans in this direction are presented. A broker component has already been implemented applying a Semantic Web layered architecture. Its mission is to mediate in a restricted community of digital video providers and distributors, benefiting also final purchasers. The intention is to use it as a test bed for this promising initiative and its application in the Intellectual Property Rights (IPR) domain.

1 Introduction

The Internet, and more concretely Web technologies, has matured, passed the promises phase and is currently firmly established in our society. Now it takes part of our daily life, it is in the appropriation phase [1]. We are trying to profit, economically or not, from it, as we did with other revolutionary ideas that arose before. Now, we can observe with greater perspective and calm what has been achieved and what can be done further. It seems like new phases must be engaged, solving the new problems that came up and, why not, making new promises.

One of the biggest problems, strongly founded on the consequences of the overall Digital Era, is the easy copy and ulterior uncontrolled distribution of multimedia creations. This motivates new approaches to intellectual property management, mechanisms by which the authors of these materials and all other implicated actors get fair revenues from their efforts. However, the management of such features in the current Web environment, decentralised and enormously dynamic, becomes almost impossible if these mechanisms are not largely automated. Therefore, the real problem is the lack of an easy automation framework in the current Web, as it also happens to other initiatives in the field, for instance thus centred on resource location.

This fundamental problem is the focus of the new Web environment initiative, the Semantic Web. The migration of the interoperability layer from the syntactic to the semantic level is the base of this initiative. This new approach, despite less suited a priori to computer abilities, provides a more capable base for the automation of complex processes in a highly heterogeneous environment like the Web.

The Semantic Web is the core of all the work presented in this paper. It has been applied to its main objective, the use of semantics in the Web for IPR conceptual modelling. In addition the implemented business model and architecture will be shown, since there is already a developed part and in order to provide a practical context.

Work already done has been co-financed by the Catalonian Government initiative to establish a pilot infrastructure of the future Internet 2. Concretely, inside the multimedia cluster that explores the multimedia capabilities of this evolution of the current Internet, especially for video distribution. The developed application, called MARS (Multimedia Advanced brokerage and Redistribution Surveillance), deals with video IPR management for a group of video producers that also participate in the project. However, it is important to remark that despite this initial focus, it can easily upgrade to any type of intellectual property resources and to wider environments, mainly thanks to the semantic approximation choosen.

2 Approach

In this section, we depict the different facets that explain the way the described project has been considered. They have marked the development until now but have even greater influence in the future work.

2.1 Intellectual Property Rights and the Semantic Web

Since now the Web is more and more business oriented, organisations in all sectors are trying to automate its processes and relations to improve services, reduce costs and attain global markets. However, these efforts are finding great difficulties, especially when considering its implementation in the wide and open environment that the Web provides. Moreover, the multimedia creations sector is not one of the easiest to deal with.

There are many problematic issues. The products in this market are not clearly defined ones. They can have multiple independent components that involve multiple actors with different rights over this material. Consider, for instance, a sophisticated Web advertisement, with a soundtrack, some good quality photos, a synthetic animation of the product to clearly show its functionality, etc.… Related to this, there is the identification problem of all these creations and the actors involved.

Finally, there are the interoperability problems that an automated approximation to this problem will find. There exist many different vocabularies to deal with intellectual property, derived from diverse cultures, legislations, communities… This is the key issue to extract full potential from an automated platform for IPR management can provide. Understanding between parties using different vocabularies is fundamental. Therefore, there must be a supporting layer enabling such mappings, since no communication is possible if there is not a common base.

All these requirements fit pretty well in the features Semantic Web is promising. Indeed, we can now observe some initiatives in this direction, as it could be observed in the last W3C Workshop on Digital Rights Management [2]. Therefore, our intention in the underway

MARS project [3] is to develop an IPR management system that profits from Semantic Web features. It should appear completely integrated in the Web, facilitating interoperability and allowing advanced processes automation by extracting full potential from the provided semantic layer.

As an overview, detailed further, our plans involve the following Semantic Web building blocks:

- URIs as identifiers. This includes URNs when persistence is needed. They are used to identify creations and to reference digital certificates. The latter, in conjunction with digital signatures, will allow actor identification and validation of the statements they made.
- Ontologies. They define the different vocabularies used during statements construction. They are not limited to the intellectual property domain, some model more abstract levels or describe concrete multimedia types, for instance videos. Ontologies are interconnected, directly or by common upper levels, so interoperability through mappings between them is feasible.
- Metadata carrying semantic annotations. It is the framework that merges the previous pieces. Metadata fragments will talk about a resource through an URI and use ontology words and the semantics they define.

2.2 Semantic ExtraWeb

Although Semantic Web initiative has great potential, it is still at its beginnings. For the moment, as it happened to the initial Web, it is being applied to very limited and more or less closed environments, sometimes called Community Web Portals. We can also use the more general term Semantic Extrawebs, since they apply to the same scope than the well-known extranets. However, Semantic Web has openness in its foundations, inherited from its Web origins, and this establishes a great difference with other similar initiatives. In the future, it may upgrade easily to the global domain aggregating independently developed initiatives.

Therefore, for the moment, the developed system is intended to cope with the necessities of a small community of users in the multimedia environment. This is not a handicap for future wider extensions or interactions with other previously endemic communities. As has been said, interoperability is one of the main features of the Semantic Web, as can be read for instance in [4].

2.3 Business model and brokerage

Figure 1 shows the general IPR model that has been considered. It is inspired by the one defined by the Imprimatur project [5].

However, we have simplified this model considering the necessities of the community participating in our project. This allows us to facilitate implementation without losing any characteristic because the application environment does not have the entire requirements covered by the complete model. First, the number of actors has been reduced because the main participants in our project cope with the three top roles of the value chain, shown in the centre of *figure 1*.

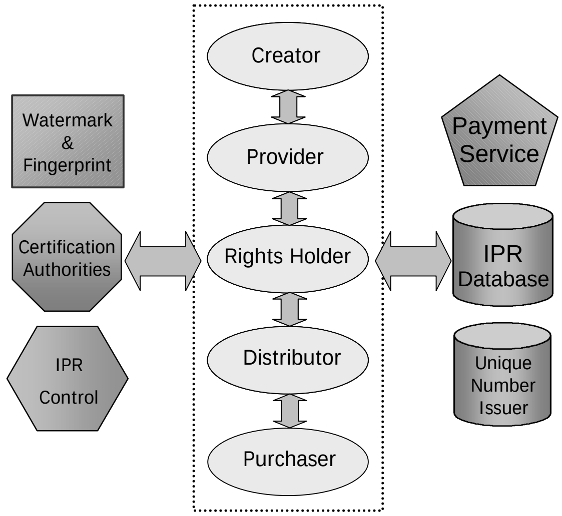

Figure 1: general IPR model

A further modification is the introduction of a new entity that will coordinate all the services provided to the value chain. Brokerage is a main issue in e-commerce environments [6][7]. Therefore, a broker will be the main interacting party for the other actors, hiding them the complexities of the whole model. At the same time, it presents a unified view to all the available services. The broker can also coordinate actions in an efficient and coherent form because it has a central and complete view of all that occurs.

The final considered business model is presented in *figure 2*.

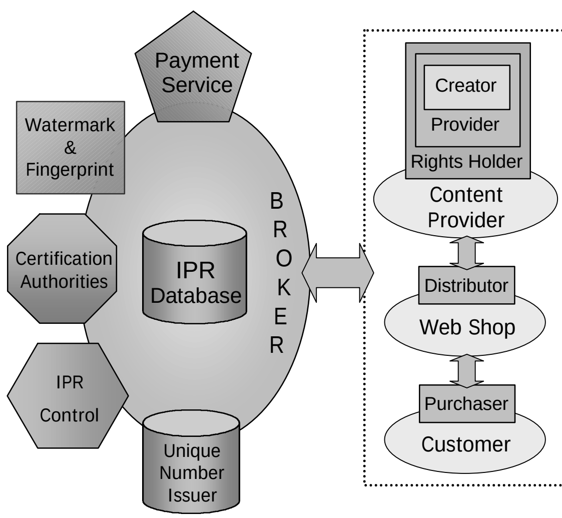

Figure 2: Considered business model

Two of the provided services must be highlighted because they are tightly connected to the undertaken approximation. They are the *Watermark and Fingerprint* facility and the *IPR Control* service. They appear because IPR control, and not IPR enforcement, is the method we have implemented to ensure that all the actors get the expected revenues. There have been many attempts to implement methods that restrict uncontrolled multimedia contents distribution. However, until now, they have not had the expected results. They have not succeeded because they impose proprietary software, or even hardware, solutions and contradict the current openness and multi-device tendencies.

Therefore, our approach comes from a different point of view. Digital multimedia materials treated by the application do not carry any mechanism to avoid its copy and redistribution. Instead, they are watermarked, they contain an invisible digital mark that contains an identification number. It is inserted with a password that must be provided later to retrieve it.

On the other hand, modular chunks of metadata are also associated to multimedia resources. They explain, in a machine understandable way, the rights situation of these multimedia streams of bytes and other characteristics. No need to say that such streams, with so complex senses for us, are hardly understandable for computers. Therefore, metadata must have the necessary expressive power to deal with the complexities of the intellectual property and multimedia field.

These metadata annotations, in conjunction with the possibilities of digital signatures and certificates, can be used as proofs on transmission and licensing of rights on intellectual property, i.e. digital contracts. For instance, we can get a system mainly based on licensing, where this semantically modelled licenses and other statements allow a great level of automation of their processing [8].

Among this processes there is *IPR Control*. Its commitment is the continuous monitoring of the Web, focusing in those services providing multimedia material online. When a suspicious digital creation is found it tries to identify it. There are three kinds of identification:

- If the creation is not watermarked, or the mark is not accessible, identification could be done by contextual information or some unique characteristics.
- If a watermark is retrieved, automatic identification can be very reliable. There is also the possibility that more than one watermark is found, identifying different component creations.
- There is also the possibility that the creation has a fingerprint. This special watermark, not only identifies a creation, but also determines a concrete transaction.

Results could not be accurate enough in the first case. For instance, from the video title appearing in the controlled Web page a controlled video copy corresponding to it can be located. Digital videos can be compared, e.g. total length or some key frames. Finally, if it is not possible to determine identity, pre-established with a similarity threshold, identification may require human intervention. Therefore, the watermarks and fingerprints present in the other two cases are very useful.

Finally, after identification, the relevant IPR statements are retrieved. Thus, we can check if the intellectual property is available in a situation under its rights statements. In case the identification has been done thanks to a fingerprint, we can even track to the last controlled transaction on this creation.

If any problem is encountered then we enter the legal scenario. Now, we have some clues pointing to a party that may have bypassed the rights it has acquired and, at least, one actor using a creation under unlawful conditions, from the IPR statements perspective. Here we must return from the world of bits back to the world of atoms. Affected parties must be notified and then laws have the floor. At this point, our system has nothing to do and we must rely on laws application. However, some help can be provided, digital signatures have legal support in some countries and signed contracts and notarisation of the IPR database can be considered in the legal scenario. We hope, in the future, laws and technology may evolve more aware from each other and mutual support would be easier.

To conclude, we must say that, although the business model points to IPR control, the application per se is not limited technologically to this methodology. The components focusing on this control solution are only Watermarking and IPR Control. However, semantic IPR statements can be used also for rights enforcement.

3 Architecture

This section will describe the architecture of the application we are developing. It is composed of the broker and some related tools, shown in *figure 2*. The provided view is structured in layers, see *figure 3*, starting at the final user side with the presentation layer and then going deeper in. Application logic layer provides the high level services available for the intervening actors of the multimedia value chain. Knowledge layer is the application core setting the vertebral column for the whole initiative, which is made persistent using the storage layer at the bottom.

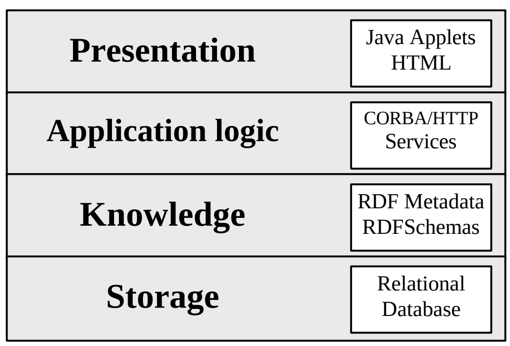

Figure 3: Layered application architecture

However, we will explain the different layers in an order more coherent with the followed development process. We started conceptualising the domain, i.e. establishing the knowledge layer. Then, over the previous structure, the services required by the actors were defined inside the application logic. Finally, the persistence and the user interface were completed.

3.1 Knowledge layer

This layer has guided the application development from the beginning. Its mission is to create a well-established conceptualisation of the domain, in our particular case a digitalised multimedia market. More specifically, it is an environment for video commercialisation structured following the previous business model, centred in supporting IPR management of these digital assets.

The fundamental objective is producing a machine interpretable model and thus to make the conceptual level the automation support point. We have followed Semantic Web guidance and, in this initial phase of the project, only the more basic tools it provides have been used. More sophisticated ones were not available when the project started or just announced.

Therefore, we use RDF [9] and RDFSchema [10] as the building blocks of the knowledge layer. RDF uses URIs as resource identifiers and becames the language to express the metadata that describes video semantics. Nevertheless, the real semantics carrier resides in the structure of the vocabularies used by the metadata language. These vocabularies are implemented using RDFSchema.

These key issues of the knowledge level (identification, vocabulary and metadata) are detailed in the next sections.

3.1.1 Identification

URLs are the way things are named in the Web but URLs have a serious problem, its persistence. We can get one URL to some Web resource but it may be unavailable in the future or point to a completely different thing.

To avoid this problem and enlarge the set of things that RDF can refer to it uses URIs [11]. These are very similar to URL, indeed URIs include URLs, but they are an identification system, not only locators. Formally, any identifiable object, real or virtual, can have an URI and, what is more important, URIs also include URNs. These are especial ones because they have an institutional commitment to persistence. This can be reduced to a kind of mapping service from the URN that continuously identifies it to the location where it can be actually found, which is an URL. It can also provide more information but, at least, we have the institution compromise this identifier is stable.

Therefore, URIs give us a very flexible identification system. Commonly we will use directly URLs in the IPR statements we construct with RDF. This is not a problem if we have a clear idea about what the URL is pointing to. Nevertheless, in some cases it would be preferable a more Web-independent and deeply founded identifier.

For instance, if we are talking about a book it is preferable to use the ISBN that actually is identifying it, in URN form *urn:isbn:84-85081-95-1*.

In our case, we will use URN when talking about creations in their abstract form, this is a video as an intellectual creation. The mapping schemes, or institutions that make the persistence commitment, can be specialised ones like in the books case or other oriented to the digital environment, like the digital object identifiers provided by DOI [12].

For the moment, because the system is pretty closed and for testing purposes, the broker is acting as an identifiers issuer in the form of URNs, like *urn:mars:687455*. Nevertheless, the broker can be completely transparent to this matter. Creations can be previously identified and this identifier provided to the broker, although always in URI form. In the other hand, when talking about a concrete copy of a video available in a defined location, an URL will be used in the common way. For example *http://video.provider.org/687455.mpg*.

Finally, all the intervening actors also need identification. The intention stated in the approach was to identify them by using digital certificates. Profiting from this public key infrastructure digital signatures would also be used to track responsibility in the transactions actors realise. However, this module has not been adapted yet. Now, we use the traditional user-identifier and password method, so this issue is moved to the future work section. Currently, the broker generates these user identifiers, like the previous video creations identifiers in URN form.

3.1.2 Vocabularies

Ontologies, formalised vocabularies, are the building blocks of the Semantic Web. Indeed, the Semantic Web tools provide only the grounding over which different vocabularies can be developed and interconnected, facilitating its reuse and refinement.

In the MARS project, some of these vocabularies have been used to construct the conceptual model of the application domain. Some are reused and some are RDFSchema implementations of previously defined conceptualisations. Finally, the uncovered aspects have been attained developing the application specific ones.

Any RDFSchema can be reused. Actually, the application is reusing the Dublin Core [13] RDFSchema. This provides a very generic set of properties for basic creations descriptions. However, other possibilities exist, the most remarkable could be future schemas for MPEG7 [14] that would allow very detailed video descriptions.

The basic schema, that provides the groundings of the application domain model, is a RDFSchema implementation of a predefined model. Work started from the results of the INDECS [15] project, mainly a structured dictionary of terms for metadata related to the e-commerce of intellectual property. Its focus is providing an interoperability framework for this sector so it was a good starting point for the implementation of a schema for IPR management. First, a deep study of the INDECS documentation resulted on a clearer hierarchical view. The upper levels and the connection we made to RDF for its posterior RDFSchema implementation are shown in *figure 4.*

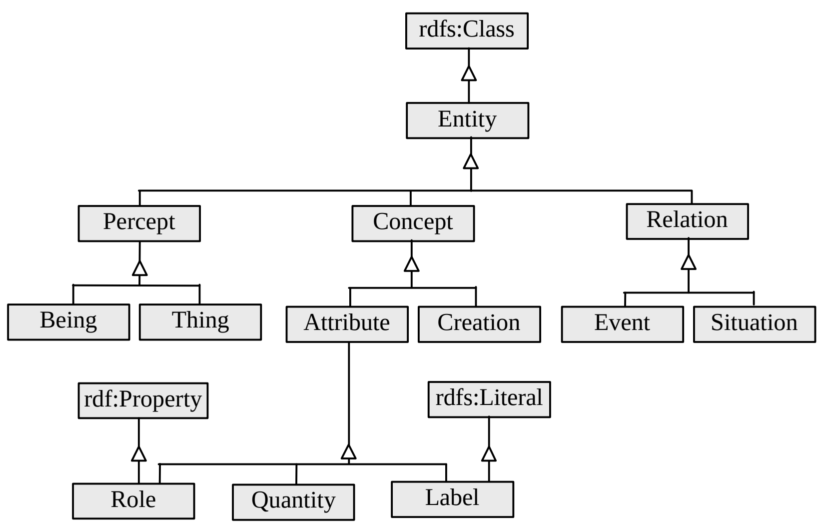

Figure 4: MARS INDECS-based upper ontology levels

After that, a minimal implementation of the whole model was made resulting in a RDF schema. We focused on the indispensable parts for our concrete application. The basic upper levels and those necessary for IPR modelling were the main interesting parts.

On top of that, the more concrete part dealing with videos, and other features specific to our approach, were constructed. This new schema is not an isolated part, it is grounded on the INDECS based schema by refining the appropriate concepts it defines. For instance, we added some concrete intellectual property rights so real IPR statements can be done. Some of these extensions are presented in *figure 5*, where original INDECS concepts are preceded by the *indecs* alias.

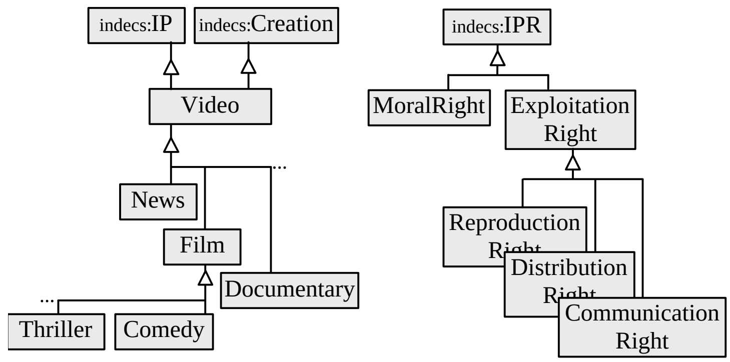

Figure 5: Some concepts defined in mars-schema

3.1.3 Metadata

Now we have the methods to refer to resources and some words to say things about them. There is an example of metadata in *table 1*, a set of RDF statements serialized in XML form about a video documentary. This is only a video description.

Table 1: Video resource RDF annotation

```
<?xml version="1.0" encoding="UTF-8"?>
<rdf:RDF  xmlns="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
          xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
          xmlns:dc="http://purl.org/dc/elements/1.1#"
          xmlns:mars="http://dmag.upf.i2/schemas/mars/video#"
>
<mars:Documentary rdf:ID=”urn:mars:3928172”>
    <dc:title>Climate change</dc:title>
    <dc:description>
        Some reseach groups. . .of the planet.
    </dc:description>
    <dc:language>en</dc:language>
    <dc:date>1999-06-27</dc:date>
    <mars:markedCopy
        rdf:resource=”ftp://mmm.upc.i2/30m-climatics.mpg”/>
    <mars:preview
        rdf:resource=”vstcp://192.168.48.3:5000/climatics.mpi/>
</mars:Documentary>
</rdf:RDF>
```

A more complex example dealing with IPR statements is shown in *figure 6*. It presents a graph view of a set of statements modelling an IPR agreement between two hypothetic parties, *Gamma Productions* and *Wide Distributions*. The former is transferring the *Reproduction Right* for a limited time to the latter. Furthermore, it is licensing the dissemination of a concrete number of copies worldwide for the same period using the Internet. *Gamma Productions* revenue is a fixed payment of 1000€ plus a 5% royalty rate. This agreement can be easily expressed using the RDF Data Model and consequently serialised in its XML form.

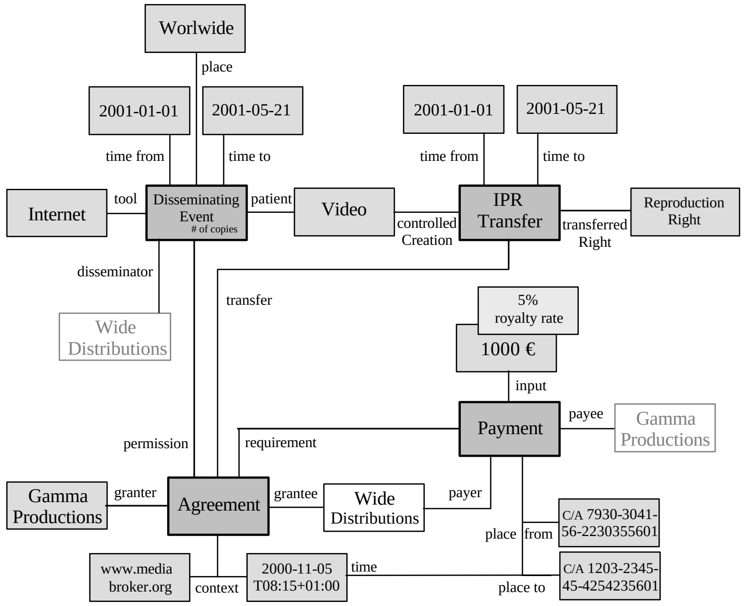

Figure 6: Graph view of an IPR agreement

It can serve as an example of the great expressive power that can be achieved using the basic tools of the Semantic Web, RDF and RDFSchema.

The conclusion of this part is that, although not visible, the important thing behind these chunks of metadata is their hidden semantics that emerge from the structure and interrelations of the used RDFSchemas. Now, we will move to the application logic level, where all this knowledge is really used. There, in an automated environment, they will be more significant.

3.2 Application logic layer

The broker provides a CORBA [16] interface to the entities willing to use their services. The actors in the considered model, especially content providers and distributors, can use this interface or http encapsulations of it with Java Servlets [17]. The remaining actors, the purchasers, will interact with the system through more user-friendly interfaces, distributors will provide them with web video-shops.

Available services for the business model roles are shown in *table 2*.

Table 2: Available services for the business model roles

Affiliated (any registered user)
- affiliate(string rdfUserDescription)
- login(string affiliatedId, string password)
- getRightsHolderRole()
- getDistributorRole()

RightsHolder (content provider)
- register(string rdfVideoDescription)
- offer(string videoId, string markedProductLoc, string markKey)

Distributor (or a purchaser through distributor's web shop interface)
- getSchemas()
- search(string xmlQuery)
- buy(string markedVideoId)

For the moment, the logical layer focuses on facilitating storage and retrieval of video descriptions and IPR statements about these videos. Therefore, the real work carried out in this layer reduces to profit from semantic annotations to improve searches for registered videos.

Queries are sent using the *search* method of the *Distributor* role. Actually, a XML formatted string is fetched containing a multiple property-value query with logic connectives. This allows easy integration with common web shop's forms without restricting the available properties. The used schemas determine the available properties and they can be listed with the *getSchemas* method. The broker contains an independent module to map XML to internal queries so new and more expressive query formats can be plugged in.

Future work, presented in section 4, will try to extract its full potential from the knowledge layer, which will also be improved. These enhancements would allow more sophisticated services, some of them sketched then.

3.3 Storage layer

Supporting all the system there is the storage layer, it provides the necessary persistence. A RDF oriented mechanism has been adopted, the RDF Data Model is directly stored in a database in its triple form. This allows a Relational Database implementation using only a table for triples. We will refer to it as the monolithic approach.

However, to avoid redundant storage of entities with many properties, or entities or literals referred as values of diverse properties, we have taken them out of the main table. To improve efficiency, digests of all entity and property identifiers, i.e. URIs, are used as the real table identifiers.

Consequently, entities and literals were stored in different tables, but this introduced a lot of problems when translating user queries to SQL ones, they became really complicated. We opted to unify both tables and to add a new attribute, *isLiteral*, to easily differentiate literals from entities. This increases searches efficiency; when we find a literal, as there cannot be properties applying to it, we can stop searching for them.

The database design can be seen in *figure 7*.

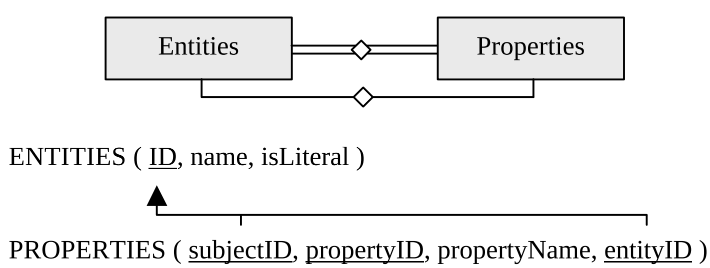

Figure 7: EER diagram and table intensions

A completely knowledge-independent storage medium has been obtained. The database does not suffer any change when new schemas are developed or reused. Even the previous and new schemas are stored in the same medium, because they are expressed using RDF and, consequently, they have a triple form that allows their transparent storage in the database.

3.4 Presentation layer

Finally, this layer contains all that purchasers will see when interacting with MARS services. As mentioned before, the user will interact through the Web pages of the distributors' video shops. These pages are totally out of the main MARS development process, though we have implemented a minimal web shop for testing purposes. In addition, we have developed a tool to facilitate that distributors use broker's search capabilities without great effort.

The tool takes the form of an easily integrable Java applet. It provides a palette of properties and classes for each of the available schemas and, when a concrete property is selected, help on possible values. *Figure 8* shows a capture of it.

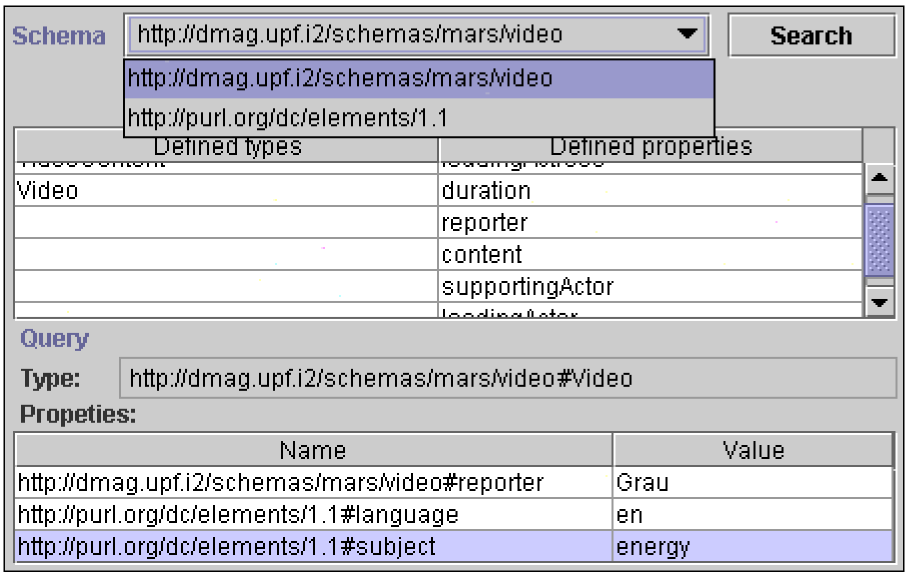

Figure 8: Query construction applet.

4 Future work

Not all the planned work has been finished and even the completed part needs an update, since new advances in the field are continuous. Therefore, there is still a lot of work to be done. Some of these future intentions are depicted in this section. They are presented following the layered structure of the architecture, each improvement is described in the section where it takes place.

4.1 Knowledge layer

This layer is one of the more affected by the future advances of the Semantic Web, consequently it is going to cope with a great part of the future work.

4.1.1 Ontologies

In the future, we are going to stop talking about schemas. New languages on top of RDFSchema have been developed and they allow expressing what now can be considered as real ontologies. Therefore, future plans in the knowledge layer will centre in upgrading the developed schemas to the possibilities offered by ontology capable languages, like DAML+OIL [18].

Moreover, we are going to substitute the current upper levels inherited from the INDECS model with those from another ontology really focused on this matter, like SUO [19]. Nevertheless, the more concrete levels of INDECS, mainly those concerned with IPR, will be maintained but adapted to be founded in the new conceptual base level. It will not be really a replacement process, it will be implemented, if possible, by cross mapping the old and the new upper levels. Acting this way will allow greater interoperability and backward compatibility between the different versions of MARS. Therefore, even INDECS unaware application would communicate, or at least partially understand all the metadata generated by MARS.

Finally, one of the problems that have come out is the sparse diffusion of metadata in the Web. To reduce its impact, a lexical layer will be put under the main part of the application ontology. This will allow ontology driven information extraction from natural language. Metadata will be easier to produce or will be automatically retrieved, for instance from Web pages. This can be faced using a lexicon like Wordnet [20], although it is limited to English. However, recently the EuroWordnet [21] project has extended it to other European languages.

4.1.2 Trust

As commented in section 3.1, the use of public key infrastructures has been moved to future work. The primary intention is requiring that each actor taking part in the systems have its own digital certificate. This certificate, with its corresponding private key, will be used for digitally signing all the statements done by this actor (agreements, offers, assertions…) so responsibility can be tracked later and even produce contracts.

We are planning to apply digital signatures at the RDF Data Model level [22], not to its serialised form. This approach avoids ambiguity problems while maintaining the flexibility RDF annotations provide.

4.2 Application logic layer

This layer may also receive a lot of work. However, unlike the previous one, it will not have the priority. This is because this layer feeds on the semantics generated by the knowledge layer. Therefore, the new extensions will be undertaken when all profit from a well-developed knowledge level can be taken.

However, a research line classifiable under this section is already been designed and first implementations are been produced. It is a mobile agent platform related to the IPR control service. It would consist of a brigade of mobile agents patrolling the Web randomly or focusing on suspicious user constrained zones. Their mission will be, when possible, to automatically test the IPR situation of the found multimedia items against available IPR databases [23]. In addition, we are considering automatic, or partially assisted, negotiation on multimedia assets carried out by agents [24].

However, to enable sophisticated and highly automated implementations, more powerful tools are necessary. The Semantic Web has been until now very focused on representation issues, and less effort has been made to exploit these representations. That is reasonable because the latter needs that the former is well established before advances can be done. Following these trends, we are now considering Conceptual Graphs [25] as on of the formalisms to apply to the logical level.

Conceptual Graphs, due to their graph oriented philosophy, seem well suited as RDF/RDFSchema extensions. Indeed, some proposals to map between Conceptual Graphs and RDF/XML have been done [26]. Conceptual Graphs can also be translated to and from predicate logics, so integration with other initiatives in the field is possible, like DAML-L [27].

4.3 Storage layer

The intention is to continue using common relational databases, they are widely used and this facilitates implementation and deployment. However, some improvements can be done, for instance using Object Relational Databases. They provide *subtable* relations between tables that simplify queries on subtype hierarchies, this allows simplifying the current complex and inefficient SQL queries.

We are also considering using pre-build RDF storage packages, like the ICS-FORTH [28] RDFSuite. This package provides advanced storage of RDF metadata and enhanced mechanisms for retrieval, a SQL like language and RDF oriented called RQL.

4.4 Presentation layer

Finally, we are also planning to use Conceptual Graphs in the user. We can profit from its graphical orientation to develop more intuitive interfaces, allowing a more sophisticated level of interaction. For instance, graphical conceptual graphs editors could guide user interaction, during resource description or query formulation, profiting from domain knowledge, i.e. ontologies. Therefore, the editor can recommend best-suited choices or even warn user about inconsistent constructions. *Figure 9* shows its possible appearance.

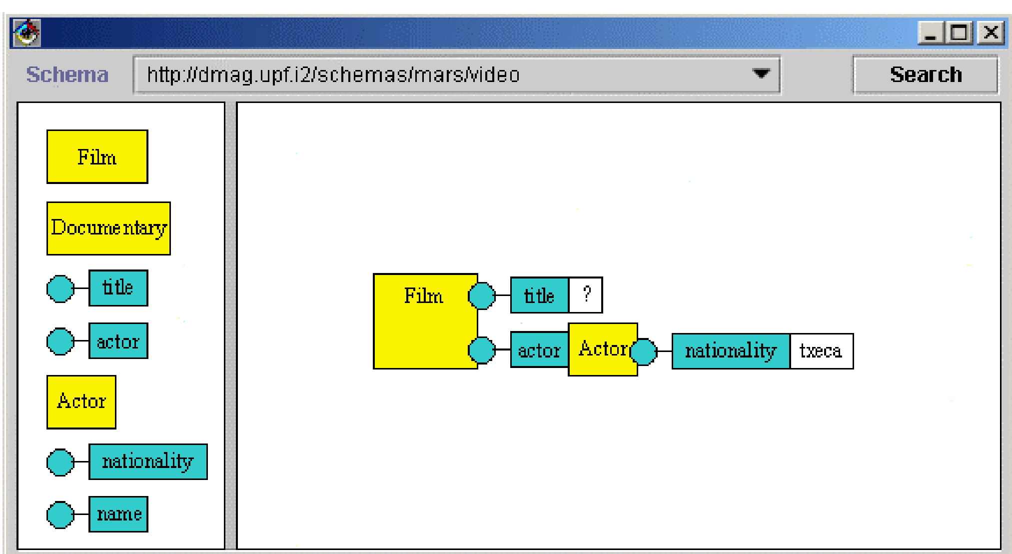

Figure 9: Drawing of a feasible query interface using graphs and ontologies palette.

5 Conclusions

Although the Semantic Web is at its beginnings, in our experience in the MARS project it has demonstrated its high potential. The promise of interoperability at the semantic level seems very appropriate in a heterogeneous domain with great expressiveness requirements, like IPR management.

Most significant improvements must be done in the business models, and it is going to be difficult to satisfy all the participants, from customers to authors. Notwithstanding, technology can provide a very valuable help in this process. Moreover, there are many other environments where this approach could give great results. Those tightly related to the Web approach (openness, decentralisation, universality…) could be specially benefited.

From a more general point of view, it has been interesting to see the benefits that a knowledge driven approximation to software development can provide. Traditionally, in the software development environment, there is a knowledge level phase were a model of the domain of application is done. Nevertheless, the produced model is only used for human consumption. When the project enters the machine aware part most of the produced conceptual value is lost. For instance, we can think about relational database models, the SQL implementation is the only view that the application has, while the Extended Entity Relationship diagram is exclusively used for documentation purposes.

Therefore, it would be interesting to profit from this initial effort, making the conceptual model machine available. The Semantic Web faces this problem using ontologies. Nevertheless, this is not revolutionary, the new value it adds is inherited from the previous Web. The Web provided the rhizome[1] approach to the information level, where the rhizome approach stands for a hierarchy less, open and decentralised way of organisation [29]. This approach, applied to information, has showed as the best suited in an Internet-connected world. Therefore, the novelty, and the challenge, is to apply it to the knowledge level, i.e. constructing a Web of interrelated ontologies.

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[1] The rhizome serves as a metaphor for the multiplicity and infinite interconnectedness of all thought, life, culture, and language. Developed by French theorists Gilles Deleuze and Felix Guattari in their book “A Thousand Plateau's” [29], from which there is an interesting quote:

“A rhizome ceaselessly establishes connections between semiotic chains, organizations of power, and circumstances relative to the arts, sciences, and social struggles. A semiotic chain is like a tuber agglomerating very diverse acts, not only linguistic, but also perceptive, mimetic, gestural, and cognitive: there is no language in itself, nor are there any linguistic universals, only a throng of dialects, patois, slangs, and specialized languages. There is no ideal speaker-listener, any more than there is a homogeneous linguistic community.... There is no mother tongue, only a power takeover by a dominant language within a political multiplicity. Language stabilizes around a parish, a bishopric, a capital. It forms a bulb. It evolves by subterranean stems and flows, along river valleys or train tracks; it spreads like a patch of oil. It is always possible to break a language down into internal structural elements, an undertaking not fundamentally different from a search for roots. There is always something genealogical about a tree. It is not a method for the people. A method of the rhizome type, on the contrary, can analyse language only by decentering it onto other dimensions and other registers. A language is never closed upon itself, except as a function of impotence.”

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