Electronic IPR (eIPR) Management Technologies

Franco Bartolini[*], *Roberto Caldelli*[*] *and Vito Cappellini*[*]

(*) Department of Electronics and Telecommunications, University of Firenze
Via S. Marta 3, 50139 - Firenze, Italy
E-mail: {barto, caldelli, cappellini}@lci.det.unifi.it

ABSTRACT

The progresses over the last few years of digital technologies, the rapid development of the Internet and of other communication means, have caused an ever increasing need for protecting Intellectual Property Rights (IPRs). The problem of the IPR protection for multimedia works exchanged through telematic networks have promoted industrial and research projects for the development of Electronic Copyright Management Systems (ECMSs), i.e. systems able to manage automatically all the issues related to trading works through telematic means by protecting their IPR. The goal of this paper is to exploit the main requirements that such systems should satisfy, the players that should be involved and the technologies that will be most probably employed.

KEYWORDS: IPR protection, ECMS, MPEG.

INTRODUCTION

The progresses over the last few years of digital technologies, the rapid development of the Internet and of other communication means, have caused an ever increasing need for protecting Intellectual Property Rights (IPRs). Traditional laws on IPR protection do not seem suitable to solve all the problems raised by this technological revolution. Just the fact that each work could be easily digitised, stored and transmitted without loss of quality an almost uncountable number of times, is causing, at the international level, the revision of the concept of IPR protection itself. On the other side the large diffusion of Internet, more than a menace of increasing copyright violations, can be, for the authors and the copyright owners, a good chance to diffuse their works and a big business opportunity 1. In the United States a White Book regarding the problems related to the protection of the Intellectual Property Rights in the Information Society has been published on 1995: it gives suggestions regarding the modifications needed by American laws on Copyright (*American Copyright Act*) to consider the new digital and network scenarios. In 1996 the WIPO (World Intellectual Property Organisation) supported the signing of an international treaty, whose main statement is that copyright protection must be granted also for works transmitted through electronic media. All these documents witness the interest for the problem of the IPR protection for multimedia works exchanged through telematic networks and have promoted industrial and research projects for the development of Electronic Copyright Management Systems (ECMSs), i.e. systems able to manage automatically all the issues related to trading works through telematic means by protecting their IPR.

REQUIREMENTS

An ECMS can be considered as an ensemble of services, connected through a network environment, co-operating together, to allow the protection of the IPR of multimedia data, on the basis of contracts agreed among the involved parties. In particular, two technological revolution have made the problem of IPR protection so new and challenging today. The first is the advent of digital techniques, and the second the explosion of telematic networks. The possibility to represent every kind of work (being text, picture, video, music, ...) in a digital format has given birth to a new type of creation, i.e. multimedia creations, where different kind of data can be integrated to produce a new composite object. This possibility offer a big chance to authors to better express their creativity, but, on the other side, the IPR problem becomes quite complex: in order to compose the new object, all its components have to be licensed by respective authors; an ECMS should, thus, allow to easily track the information related to the IPR of each component. Furthermore works in digital format could be copied almost an infinite number of times, without any degradation, thus encouraging the trading of illegal (i.e. not licensed) copies of the creations. The development of open telematic networks (in practice Internet) makes highly easier the distribution of creations, thus increasing both their diffusion and their business value. This is again a big opportunity for authors. Nevertheless, some problems are also coming, together with the advantages: in particular illegal distribution becomes easier too, and privacy issues have to be dealt with. One of the most important requirements of an ECMS is that it should be able of efficiently playing in an open network environment, and consequently to deal with security problems. In particular, two aspects are implied: first integrity of the electronic transactions must be granted, in such a way that users can be sure that they obtained what they really asked for, and the rights are paid to the true copyright owners; second the users would like their privacy to be preserved. It will be very important to build up archives where the information on the IPR of a particular work could be stored and easily retrieved, in such a way to grant the correct distribution of the fees to the copyright owners. Such archives should also be able to make available this information at different level of detail, according to the type of user who is accessing it: a purchaser would only need superficial data (e.g. regarding authors, year of creation, an so on), while a right-holder should be able to access (and possibly modify) also confidential data (e.g. shares, prices, and so on). An ECMS should also be able to deal with the new type of transactions, typical of a digital environment, as for example licensing sub-parts of a creation. An ECMS should also offer means to track copyright violation, and allows to honest purchasers to demonstrate that they legally acquired a creation. Thus some way should exist to securely link the copyright information to the works that are to be traded. Another requirement which is strictly connected to the two just mentioned (i.e. the set up of IPR information archives and the need for linking copyright information to the creations), refers to the ability to be exhibited by an ECMS to manage some way to identify the creations. With this aim a big effort is currently being done by international standard organisations such as ISO and CISAC, to develop a Digital Object Identifier (DOI), that should be used for every kind of creation (being it a text, a

picture, a video, a music piece, etc.) and that will represent for digital creations what are now ISBN and ISSN for books and periodicals. Most probably an ECMS will need to be able to work in a multi-code environment, given that it will be very difficult that an unique code will be used for every type of creation, at least in the next years. Furthermore an ECMS should be as easy as possible to be used by a purchaser who is interested to legally acquire copyrighted materials, in order not to deter such a kind of use. Besides to end users, ease of use should also be granted to those authors who are interested in developing composite creations, and thus need to retrieve the information related to the IPR of a work in an easy, and secure way. Indeed the problem of ease of use is very important: many today proposed solutions, in an attempt to grant IPR to be preserved in a strongly secure way, offer to the users a service which is complex to be used. In this field a trade-off will need to be found between the interest of IPR owners (for whom security is the main issue) and of end users (who will not use systems which are too complicated). In this area will be played the success of ECMS.

THE GENERAL ARCHITECTURE

For understanding all the issues related to *e*IPR management, it is convenient to refer to a so called, business model, that is to a model describing all the players involved in the exchange of works as well as the transactions occurring among them. In particular we will here refer to the Business Model developed in the ESPRIT 20676 IMPRIMATUR Project 4 whose scheme is depicted in Figure 1.

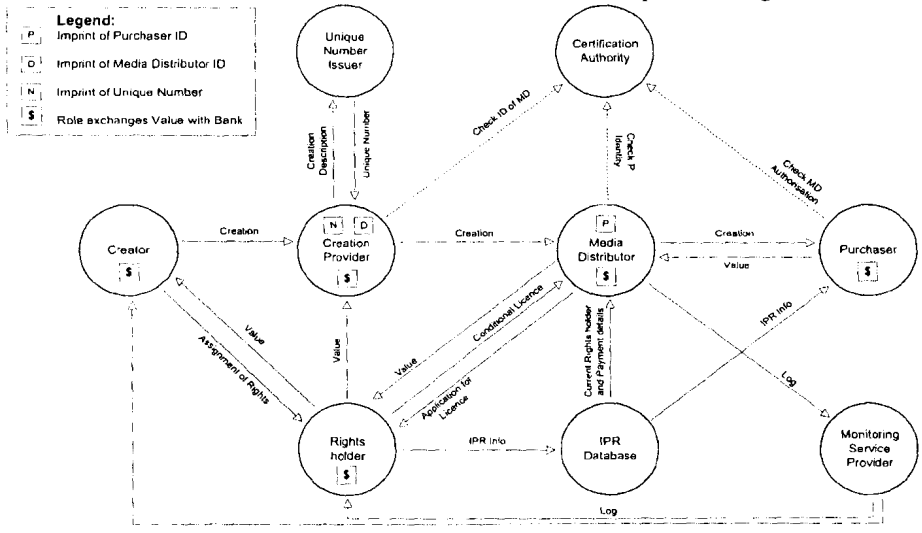

Figure 1 Scheme of the IMPRIMATUR Business Model

It is not always needed that all players are present and all transactions occur, simplified processes can be implemented according to the particular type of application and to the needs of the users, anyway the scheme of Figure 1 offer a comprehensive and general overview of the mechanisms that could be implied by the trading of IPR sensitive digital objects. By referring to

Figure 1 a possible simple example of business process can be hypothesised: a creator creates a multimedia work, assigns the right on it to a rights-holder he likes, and receive back some value (typically money or percentage of royalties). The multimedia work is the transferred to a creation provider who prepares it for being traded securely and forward the prepared work to the media distributor, for example an on-line shop; a purchaser accessing the media distributor site, can decide to buy the multimedia work, for which he exchanges some value (payment) with the media distributor; the media distributor forward part of the obtained value to the rights-holder. The purchaser can then get information about the IPR tied to the multimedia work he has acquired, by querying an IPR database where the rights-holder has previously stored all needed information about the IPR of the work. In this way, the purchaser can be granted that he has acquired the work in legal way, can know all the limitations of use that he has to undertake, and so on. More complicate business processes can easily be imagined by referring to the scheme of Figure 1 which is quite general. The value of such a scheme is also witnessed by the fact that it has been included as an "Example of a generic description of a model for content delivery and rights management" in the Technical Report describing the new standardisation effort of MPEG, that is MPEG-21 5.

Players

Let us now more deeply investigate the roles of the players involved in the ECMS 4. These players can be listed as:

- The author, who will be the creator of the copyrighted work.
- The rights-holder (or copyright owner). The author does not want, usually, to be involved with the administrative issues related to the management of his IPRs; he thus sells to another player the rights to exploit his creations. This player is thus mainly responsible for licensing the use of the creation: he defines the conditions of use, records the IPR information at a registry, and collects the royalties deriving from trading of the works which he is in charge to administer.
- The creation provider (or service producer), who will be in charge to prepare creations for being traded in the ECMS, and thus, for example, to embed into creations those mechanisms that will allow the tracking of copyright (watermarks). This player is the repository of the technical knowledge needed to grant that copyright can always be protected.
- The media distributor (or service provider), who will have the duty to distribute to purchasers the creations, and thus will have to satisfy the request of his clients, and to grant that the IPR on the distributed material is protected and the related fees correctly paid. This player will have to offer different simple ways to pay for the purchased works (Electronic Payment Systems), to access the databases where IPR information is stored, to be able to use all technological tools needed to protect the copyright of the creations he trades (watermarking, cryptography, secure protocols).
- The IPR register or database, which is the repository of all the information related to the IPR of the works to be protected, and that will have to be

accessible, at different levels of details and confidentiality, by all the other ECMS players.

- The Unique Number issuer, who will be responsible for assigning the unique identifier (e.g. the DOI) to each creation, for facilitating its tracking.

- The controller, who will be a Trusted Third Party (TTP) responsible for monitoring that all transactions have been carried on legally. The role of the controller is very important, and the establishment of TTPs having in charge this duty will be one of the key point for the successful diffusion of ECMSs.

- The certification authority, which is also a TTP, that is charged to authenticate all ECSM players, by means of electronic certification.

Transactions

Some of the single transactions that can occur during a generic business process related to the trading of digital objects can be listed as following:

- Transfer of the work: the work which is object of the trading can be transferred from the creator, to the creation provider, then to the media distributor and finally to the purchaser. These transfers usually occur in the just described order.

- Transfer of values: this is the exchange of money which is given for compensating the use of the multimedia work. This transfer usually originate from the purchaser, who pays the multimedia distributor, which transfer part of the value to the rights-holder which, based on previously defined agreements, will compensate the creator and the creation provider.

- Assignment of rights: the rights on the multimedia creation can be transferred from the original creator to a rights-holder (usually a licensing and collecting society such SIAE in Italy, SACD in France, GEMA in Germany, MPCS-PRS and ALCS in UK, etc.). Also in this case protection from misappropriation and forgery is needed.

Technological issues

In the realisation of really effective ECMSs some technologies will undoubtedly play a major role. In general two approaches can be distinguished to solve the problem of IPR protection: the first approach is aimed at developing systems able to prevent copyright violations (as for example the IBM proposal named Cryptolope), the second is on the contrary aimed at developing systems able to track copyright violations (as for example the ECMS developed in the framework of the EC funded project IMPRIMATUR). The ECMSs attempting to prevent copyright violations, strongly rely on cryptographic techniques: the traded work is embedded into a kind of cryptographic envelop, and only authorised users can have access to it. It seems that for tracking copyrighted material watermarking techniques will be of great help 23: they should allow to robustly embed IPR information just inside the multimedia creations, thus helping for example the controller to check the legal status of works traded through the network. Nevertheless it is today apparent that watermarking can not be considered a cure all solution, and it will be important to integrate such techniques with cryptographic tools]. In order to preserve privacy and grant

integrity of transactions secure protocols, such as SSL for on-line transactions or S/MIME for off-line (email based) transactions, will also be largely used. Finally, a key role for the actual growth of creations trading over open networks, will be played by efficient and easy-to-use Electronic Payment Systems: if these will be effective, they will encourage authors to make available their works for selling on on-line shops, and purchasers to buy them, thus making ECMSs a big chance for increasing the business opportunities of copyright. In particular, that one of the Electronic Commerce is, today, a very active and rapidly changing field. Next few months should say if very simple but not very secure solutions (as for example that used by the Amazon On-Line Bookshop) will be preferred to more secure but also more complex to be established and to be used solutions (such as for example the SET standard).

MAIN APPROACHES FOR E*IPR* MANAGEMENT

In the design of effective ECMSs, two different approaches can be distinguished to solve the problem of IPR protection: the first approach is aimed at developing systems able to prevent copyright violations (as for example the IBM proposal named Cryptolope), the second is on the contrary aimed at developing systems able to track copyright violations (as for example the ECMS developed in the framework of the EC funded project IMPRIMATUR). Both categories of systems require that multimedia works are properly managed before their distribution.

Cryptography based

Based on this approach digital objects are wrapped in an encrypted system and integrated with an application (the reader) allowing to use the work only in a controlled manner; e.g. the images can just be displayed, but they can not be printed, or the audio files can be played but can not be stored in the hard disk of the user. The content can not be accessed without the proper application. The main disadvantages of this approach is that a standard for the embedding applications is difficult to be established; moreover when the works are enjoyed (for example, they are visualised in a PC screen, or they are played), it is still possible to capture and copy them without constraint. According to this approach, some systems have already been developed: CryptoLope from IBM. and LiquidAudio. In this kind of systems the fundamental role is played by the cryptographic technologies: as a matter of fact, the traded work is packed into a ciphered box, and only authorised users can access to it.

Watermarking based

Based on this approach digital objects are watermarked through digital watermarking techniques 23 whose aim is to tightly and robustly embed IPR related information into purchased creations (the hidden data can be the name of the copyright owner, or the unique code identifying the work); it us thus possible to check the legal status of the content exchanged through the network. Nowadays it is evident that watermarking techniques can not be considered as a cure-all solution, but it will be necessary to integrate watermarking with cryptography tools. An advantage demonstrated by this of approach is the unnecessary adoption of a particular format for the watermarked multimedia content, since the IPR information are directly embedded into the content itself.

MPEG-4 IPMP

The problem of intellectual property

management and protection (IPMP) 6 was deeply felt also in the sphere of MPEG-4 standard and peculiar attention was dedicated to this issue, trying to merge the need not to limit MPEG-4 characteristics and the demand to give some effective tools for copyright safeguard. Since MPEG-4's target applications range from low bit rate Internet telephones to high fidelity video and audio systems, the intellectual property management and protection systems required had to be as diverse as these applications were; furthermore the level and the type of protection strictly depends whether on the content or on complexity and sophistication of the associated transaction models. Despite these considerations, initially it was tried to conceive a MPEG-4 IPMP including facilities such as encryption and watermarking within the MPEG-4 standard itself, but later the need not to bind MPEG-4 application potentialities and to adequately answer to the widely different IPMP requirements, led to a standardisation of a generic interface to private and non-normative IPMP systems (Figure 2).

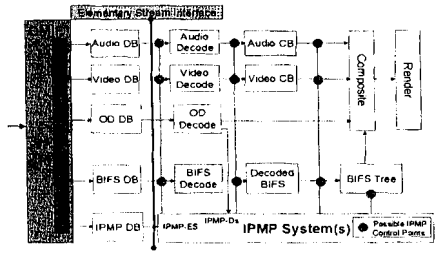

Figure 2 IPMP Framework in the ISO/IEC 14496TerminalArchitecture

This choice allows to optimise the domain-specific IPMP tools to the individual application. This interface is designed to be a simple extension of basic MPEG-4 systems constructs, it consists of IPMP-Descriptors (IPMP-Ds) and IPMP-Elementary Streams (IPMP-ES), as evidenced in Figure 2. Second ones are like any other MPEG-4 elementary stream and the first ones are extensions to the MPEG-4 object descriptors. Both provide a communication mechanism between IPMP systems and the MPEG-4 terminal; MPEG-4 objects requiring management and protection have IPMP-Ds associated with them and they indicate which IPMP systems are to be used and give information to these systems about how to manage and protect the content. In Figure 2 some possible IPMP control points (*hooks*) are indicated; these represent points, in the MPEG-4 terminal, where IPMP control might be desired and where a proprietary DRM (Digital Rights Management) system could be attached. Anyway, which has to be the watermarking approach to use, has not been standardised and which must be the peculiar features to be supplied, is not fixed, and only generic indications are to be followed. From a primary analysis, many of the existing watermarking techniques could be adopted to work in this scenario and their integration with the MPEG-4 standard does not appear so critical.

MPEG-21

The most recent standardisation effort of the MPEG, following this guideline, has been named MPEG21. Its goal is to achieve "an environment that is capable of supporting the delivery and use of all content types by different categories of users in multiple application domains" 5. Up to now 7 basic elements have been identified as constituting the framework:

A. Digital item declaration: it regards the establishment of an uniform and

flexible abstraction and interoperable scheme for defining digital objects.

B. Content representation: it regards the technologies needed for representing in a suitable way the multimedia content (this has been until now the main objective of MPEG through MPEG1, MPEG2 and MPEG4).

C. Digital item identification and description: it regards the standard to identify and describe digital multimedia content.

D. Content management and usage: it regards the interfaces and protocols for creating, manipulating, searching, storing and delivering of digital multimedia content.

E. Intellectual property management and protection: it regards the possibility of granting that the rights on multimedia content are reliably managed and protected.

F. Terminals and networks: it regards the possibility to enable transparent use of multimedia resources across a wide range of networked devices.

G. Event reporting: it is related to the possibility to describe the interaction that occurred during the use of multimedia content.

At present, in particular, the goal of MPEG21 is to identify the issues that still need a standardisation effort by ISO. Among the elements listed above, those directly connected to the problem of *e*IPR are mainly element C and element E. In particular with reference to element C it seems that MPEG21 has the aim to work to establish a framework for common digital item identification and description by harmonising and integrating with the existing standards. With reference to element E, MPEG21 has the aim:

1. to define the technical, legal and financial attributes of a trusted environment for IPMP systems (by mainly extending the work that has been already done about IPMP on MPEG4 and MPEG7);

2. to define rights expression languages for describing contractual usage rules for digital items;

The objectives of MPEG21 seem indeed very ambitious, nevertheless the benefits that could be obtained by the successful development of such a framework would be really important and could push the effort towards its goal.

CONCLUSIONS

In this paper the need to develop ECMSs to deal with automatic management of all issues related to trading works through telematic means have been highlighted; furthermore the players involved in this kind of systems and the requirements to be satisfied have been indicated. Moreover the tight connection between this sort of infrastructure and whether the standards guidelines or the EC Projects has been pointed out.

REFERENCES

1. J. P. Barlow, "Selling Wine Without Bottles: the Economy of Mind on the Global Net", in Wired, March 1994, p.85.

2. M. Barni. F. Bartolini, V. Cappellini, A. Piva, "Interoperability issues in watermark-based electronics copyright management", Proceedings of 4th Int. Conf. on Visual Systems and Multimedia, Gifu, Japan, November 18-20, 1998.

3. M. Barni, F. Bartolini, G. Bini, V. Cappellini, A. Fringuelli, G. Meucci, A. Piva, "Enforcement of copyright laws for multimedia through blind, detectable, reversible watermarking", Proc. of IEEE ICMCS, Florence, Italy, June 7-11, 1999.

4. ESPRIT 20676 IMPRIMATUR Project, "The IMPRIMATUR Business Model, Version 2.1", November 1997, *www.imprimatur.alcs.co.uk/.*

5. ISO/IEC JTC1/SC29/WG11, "TR 18034-1, Information Technology – Multimedia Framework (MPEG21) – Part 1", September 2000.

6. J. Lacy and N. Rump and P. Kudumakis, "MPEG-4 Intellectual Property Management and Protection (IPMP) Overview and Applications Document, ISO-JTC1/SC29/WG11/N2614, December 1998.

ABOUT THE AUTHORS

Franco Bartolini graduated (cum laude) in electronic engineering from the University of Florence, Florence, Italy in 1991. In 1996, he received the Ph.D degree in Informatics and Telecommunications from the University of Florence. He is now Research Assistant with the University of Florence. His research interests include digital image sequence processing, still and moving image compression, image watermarking.
E-mail: *barto@lci.det.unifi.i)t*

Roberto Caldelli graduated (cum laude) in electronic engineering from the University of Florence, Florence, Italy in 1997. In 2001, he received the Ph.D degree in Computer Science and Telecommunications Engineering from the University of Florence. He is now a Postdoctoral Researcher with the University of Florence. His research interests include digital image sequence processing, still and moving image compression, digital watermarking.
E-mail: *caldelli@lci.det.unifi.it)*

Vito Cappellini obtained, in 1975, the Full Professor degree in Electrical Communications at Florence University where he was director of the Department of Electronic Engineering and Dean of the Faculty. His main research interests are: digital signal-image processing, digital communications, watermarking, multimedia systems and art-work analysis-restoration. He is "fellow" of the IEEE, member of EURASIP and AEI.
E-mail: *cappellini@lci.det.unifi.it*