Legal Distribution of Music through the Internet

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Abstract

With communication costs falling (e.g. for ISDN or the Internet), storage capacity rising and more efficient compression algorithms such as MPEG Layer–3 (also known as MP3) and MPEG–2 Advanced Audio Coding AAC, Audio–on–Demand systems are about to become increasingly popular. This development is expected to become a very prosperous market in the near future. But besides offering new business opportunities, this development rises serious questions concerning the handling of content related intellectual property rights.

Because of these concerns, the Recording Industry Associations of America and Japan (RIAA and RIAJ) and the International Federation of the Phonographic Industries (IFPI) announced their *Secure Digital Music Initiative* (SDMI) in late 1998. Many different companies, such as consumer electronic manufacturers, technology providers, service providers and creative industries, have joined this initiative in order to develop techniques for enabling on–line and off–line music distribution systems with adequate handling of intellectual property rights.

This paper discusses both general and technical issues of establishing an *open standard* for future music delivery systems for on–line and off-line music delivery.

1 Introduction

Piracy has always been a problem to the music industries (i.e. authors, composers, artists as well as publishers and record labels) but they have found ways to cope with it. Up until now, pirates needed to produce and sell Cassettes, CDs or vinyls. This offered a wide area for countermeasures by the recording industry. Despite these efforts, the music industries lose more than $4\frac{1}{2}$ billion Euros per year to "traditional" piracy alone.

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In the emerging digital world the situation is even more dangerous: To produce and trade sound recordings in the Internet domain, factories are not required any longer, because there is no need for having a materialised data carrier (e.g. a CD). A pirate merely needs a personal computer to create copies, which he then can easily (re–)distribute via modern communication systems (e.g. the Internet or ISDN). Furthermore, it is often hard — or even impossible — to identify and, ultimately, prosecute many pirates in the Internet world, instead of a small number of "traditional" pirates.

In order to limit the aforementioned "on–line piracy", it seems to be essential to:

1. Install a legal and easy–to–use way to distribute music on–line and off–line;

2. Educate the general public about the advantages and legal status of intellectual property, intellectual property rights and copyrights;

3. Establish anti-piracy efforts, such as

    (a) Mechanisms to identify pirated material in order to remove the pirated material (e.g. from Internet sites).

    (b) A legal framework to fight the pirates and to — ultimately — sue persistent infringers.

This paper focuses on the first item, i.e. the framework to enable legal distribution of audio content. In particular, Section 3.3 proposes some technical elements and specifications for such a standard.

It is important, however, to note that applications and devices implementing this "legal way" need to be extremely easy and fun to use. If these appliances fail in this respect, the current way of distributing music in the Internet will continue to gain a significant market share: *MPEG Layer-3 (MP3) with no intellectual properties management and protection at all.* [2]

But if, on the other hand, all interested parties, can agree upon a standard that enables all parties to embrace the Internet as a distribution methodology for music, it is widely believed that on–line music distribution can become a viable business model.

To furtherance such a development, the Recording Industry Association of America (RIAA), the Recording Industry Association of Japan (RIAJ) and the International Federation of the Phonographic Industries (IFPI) announced their *Secure Digital Music Initiative* (SDMI) [11]. Many different companies, such as consumer electronic manufacturers, technology providers, service providers and creative industries, have joined this initiative in order to develop and standardise techniques for enabling on–line and off–line music distribution systems with respect to intellectual property rights.

2 The Imprimatur Business Model

When discussing technologies to establish a way for customers to legally obtain music on–line, it is important to understand the way the creative industries work today. One business model for on–line and off–line music distribution has been developed by the Imprimatur[1] project of the Esprit programme of the European Commission. Its Business Model is shown in Figure 1. [1]

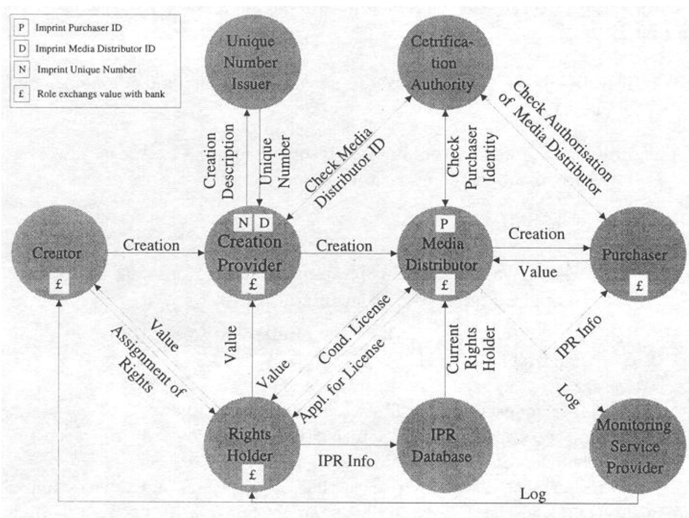

Figure 1: The Imprimatur Business Model

The Imprimatur project defines nine different *roles*, amongst whom the trading of intellectual properties takes place. These roles are the *Creator*, the *Creation Provider*, the *Rights Holder*, the *IPR Database*, the *Unique Numbering Issuer*, the *Media Distributor* and the *Purchaser*. The model describes all mutual relationships that are possible amongst these roles. It is essential, however, to understand that one person or company can simultaneously take several roles. A musician, for example, who plays his own songs on his own recordings which he distributed on his own, takes the roles of Creator[2], Cre-

[1]Intellectual Multimedia Property RIghts Model And Terminology for Universal Reference

[2]Actually, he takes the role twice: firstly, for writing the underlying musical work and, secondly, for performing the song.

ation Provider and Media Distributor at the same time. If this artist holds all rights to the underlying musical works and the sound recording as well, he is also taking the role of a Rights Holder.

Another important model of trading intellectual property is called re–distribution, or *super distribution.* One typical super distribution situation is the copying of a purchased CD to a tape and the passing of that tape to a friend of the Purchaser. If it is even possible to have the friend pay for the music which has been passed to him, additional revenue is established for the rights owners. This trade model needs also be supported by all technologies intended to establish legal ways of on–line and off–line music distribution. Again, the Imprimatur Business Model of Figure 1 helps to understand the business implications of these super distribution situations.

3 On–line Music Delivery Systems

3.1 Requirements

In order to develop technologies to establish a way for customers to legally obtain music on–line, it is important to understand the requirements, that such a system needs to fulfill. The Audio Engineering Society's Standards Committee AESSC SC–06–04 on "Internet Audio Delivery Systems" has already formulated such a set of requirements:

- Intellectual Property Rights need to be *protected.* It is clear, however, that 100% protection is not achievable. Therefore, the target has to be to make it unattractive to the general public to get to pirated music.

- The services built upon the standard need to be *very convenient* to the users. This includes that it needs to be possible to carry out all lawful what is possible today (including, for example, private copying and those transactions described in the Imprimatur Business Model). Within this framework, the protection system needs to be completely invisible to the honest user, while being a barrier for the pirate.

- Different devices and services built upon the specification need to be interoperable, i.e. tracks that have been obtained from service provider A need to be readable by the devices of provider B.

- The system needs to be *implementable on hardware* (on dedicated chips and on digital signal processors) as well as on software for personal computers.

- The system needs to be widely accepted and used so that a the market is not split into small incompatible fractions.

It seems to be beneficiary to create an *open standard*[3]. Wide–spread adoption is made much easier by adopting such a procedure. In fact, MP3 gained universal acceptance because it is such an open standard.

This openness, however, has one major drawback: Potential security holes of specification will be open to the public and it is likely that pirates will take advantage of this. But since most security weaknesses will become public knowledge sooner or later anyhow, we consider this threat to be unavoidable.

3.2 MPEG–4 IPMP

One of the first bodies to finalise a specification in the area of managing and protecting intellectual property is the Moving Pictures Expert Group (MPEG, officially ISO/IEC JTC1/SC29/WG11) with its MPEG–4 standard. MPEG–4 is a generic standard dealing with the coding of audio–visual objects and it is expected to be used in a wide variety of different applications in the multimedia world.

These audio–visual objects are — in Imprimatur terms — "Creations" and many Creation Providers are expected to only use digital distribution systems for their assets, if their intellectual property can effectively be managed and protected. With respect to this fact, MPEG has developed its *Intellectual Property Management & Protection* (IPMP) Framework within MPEG–4. [4]

MPEG–4 IPMP: Identification of Content

The MPEG–4 IPMP Framework is split into two parts: Firstly, it is essential to be able to identify content and secondly it is important to have the possibility to manage and protect intellectual property.

The identification of content is realised by associating up to 255 *Intellectual Property Identification Data Sets* to each audio–visual object of an MPEG–4 presentation [5]. Each of these IPI Data Sets can contain international standard numbers such as the International Standard Music Number (ISMN), the International Standard Recording Code (ISRC) or the International Standard Audio–visual Number (ISAN), etc. Since most of today's content is not yet identified by a standard number, the IPI Data Set offers the possibility to also identify content by so–called "name/value" pairs (e.g. "author/John Smith").

It is important, however, to identify the content but not the rights to the content. The reason for this is that rights are transitory and that they

[3]Please note, that this does not automatically imply, that no patents exist on the specified technologies. But it does imply that all patents have to be available on a fair and reasonable basis to anyone interested to build an appliance according to the specification.

can be traded between different parties, as is is shown in the Imprimatur Business Model [1].

Although the IPI Data Sets, are not technically protected against tampering, it is in many countries illegal to illicitly change or delete this information or to provide tools therefore. [13]

MPEG–4 IPMP: Management & Protection of Content

Besides identifying content, it is essential to have the possibility to actually manage and protect the content. This can be accomplished by using the *Intellectual Property Management & Protection Framework* of MPEG–4. The IPMP Framework does not standardise any specific technology because of two main reasons. Firstly, MPEG–4 addresses a wide range of different application domains and thus the requirements for the protection tools differ substantially from domain to domain. And secondly, because today's security algorithms might not be secure enough tomorrow, the temporal validity of MPEG–4 would be limited if any particular technology would have been incorporated into MPEG–4. [6]

The philosophy behind the IPMP Framework is to allow subsequent standardisation bodies, industry fora or single enterprises to use MPEG–4 IPMP for implementing specifications for their particular application domain. Two examples of such an activity take place within the Audio Engineering Society's Standards Committee SC–06–04 on "Internet Audio Delivery Systems" and the "Secure Digital Music Initiative" (SDMI) [11].

3.3 Specification

As discussed in Section 3.1, one major requirement for the success of a standard for future music distribution methods is that products stemming from the standard are *very easy and fun to use.* This includes, that all these products need to be interoperable.

This requires broad agreement upon one standard that provides a complete technical specifications, including file format, source coding, scrambling technology, key management, etc. Fixing these important parts of the specification will, however, not allow to easily migrate to a more sophisticated security technology if required sometime in the future.

To make things even more complicated, such devices as MPMan, Riō, yepp and MPlayer3 [7] are designed with low cost in mind. Therefore algorithms with high computational or memory requirements are unacceptable.

To accommodate both needs, renewable security and implementability on cost–sensitive devices, a two–layered approach seems suitable: While the first (lower) layer deals with a fixed definition for chip implementations, the second (higher) layer would allow upgradeabiliy and would be used on personal computers and other devices, where the costs do not plays the mayor role. The division between these two layers is shown in Figure 2.

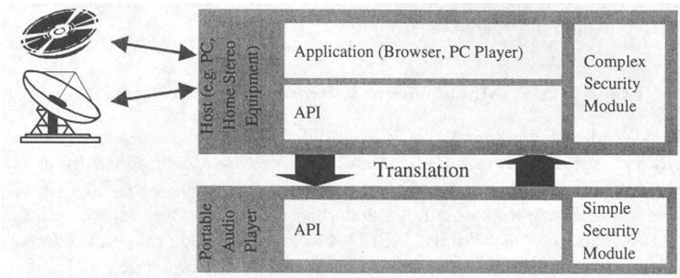

Figure 2: Two-layered Approach

In such a system, the higher layer would be responsible for the interoperability between different service providers and therefore would need to contain some translation capabilities to translate the content from service provider A to the device from provider B. The remainder of this document, however, concentrates on this first (lower) layer.

File Format

When transmitting or storing a music track two kinds of information can be identified. One the one hand, there is the music data itself, normally existing in a compressed format (e.g. MPEG Layer–3 or MPEG–2 AAC). On the other hand there is meta data. This meta data comprises of information on the intellectual property of the payload (e.g. by using the IP Information Data Set of MPEG–4), "terms and conditions" that apply to the use of the payload and information on who distributed the file to whom (preferably including an "audit" trail). Lyrics of the music track or a cover photograph could as well be part of the meta data.

A possible file format needs to combine both parts, music and meta data, and needs to accommodate several major requirements:

- The size of such a file needs to as small as possible to not diminish the high compression of the audio signal by adding huge amounts of data;
- The file need to be easy parseable, both on general purpose processors as well as on signal processors and single chips with limited resources (esp. RAM, ROM and processor cycles);

- The meta data needs to be persistently associated with the audio data;
- The payload needs to be inaccessible to unauthorised access.

In order to fulfill these requirements, a block oriented file structure similar is proposed of which a schematic diagram is shown in Figure 3.

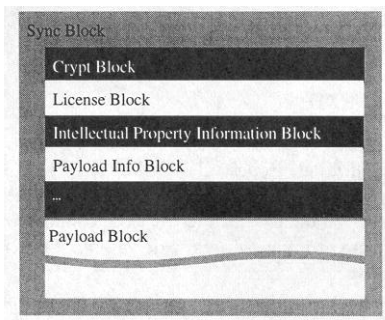

Figure 3: Block Oriented File Structure

Each of the blocks from Figure 3 will start with an identifier and an entry denoting the length of the block. Then the block specific data follows. One example of such a block in the C programming language is shown below with the "Payload Information Block", which gives information on how the payload is coded:

```
typedef struct
{
  char  ID[4]     // 'PayI'
  long  Length    // Block Length
  short Channels  // # Audio Channels
  long  Samples   // Samples/Channel
  short Bits      // Bits/Sample
  ieee  Rate      // Sample Frames/Sec.
  long  Scheme    // Compression
} Payload_Information_Block[4]
```

Other useful blocks are:

- Version Block — Identifying the version of the file format;
- License Block — containing terms and conditions of use;

[4] The type **ieee** represents an 80 bit floating point in IEEE 754 format.

- Crypt Block — containing information of how the audio data is ciphered or scrambled;
- IP Information Block — containing information for identifying the music data (according to MPEG-4);
- Embedded Header Block — containing information on "old" headers[5];
- Payload Information Block — containing information to bind meta data to music data and vice versa.

Source Coding

In order to enable interoperability — especially in the light of the fact that portable devices only have limited resources, it seems to be wise to agree upon one mandatory source coding algorithm — at least for the aforementioned portable devices. In order to give a file format for music distribution an advantage over the current model (MP3 with no protection of intellectual properties), it would be preferable to use a more advanced compression system, such as MPEG-2 Advanced Audio Coding [3][12].

In order to keep the file format flexible, however, it is suggested to include a list of optional audio codecs into the specification. These could, for example, be MPEG-1 Layer-3 (MP3), Dolby AC-3 or Real Networks' G2.

Scrambling Technologies

The same arguments that lead to the proposal to use only one mandatory scrambling algorithm per audio codec. Due to the factor that audio coding technologies are using up a significant amount of horse power, it is suggested to use a very low-footprint algorithm for scrambling the audio data. Fraunhofer IIS has developed the "Audio Scrambling" (AS) technique for — at least — AAC and MP3.

In the Audio Scrambling algorithm spectral lines of compressed audio data are scrambled by permutation. Since it is very easily possible to vary the amount of data that is changed (by varying the permutation matrix), different "awfullness" levels can be achieved. The scrambled audio data still constitutes a standard-compliant MP3 or AAC bit stream, albeit with a degraded playback quality. This allows the listener to identify the piece of music and, by motivating him to get the authorised key, benefits both the music publisher and the customer.

AS is a *very low footprint* system, and therefore, the impact on a system using AS is minimal as well on resource-limited signal processors and chips as well as on general purpose processors.

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[5] In order to not lose valuable information in a super-distribution situation, it would be of great advantage to keep old headers even if a track is re-distributed.

In parallel to possible optional source coding algorithms, it might be feasible to have a list of optional scrambling systems, including (but not limited to): DES, Tripple-DES, Blowfish and Twofish.

Watermarking

When the aforementioned access control mechanisms are overcome by pirates, a second line of defense can be established by using *watermarking* and *fingerprinting*[6] technologies: information about the intellectual property is embedded imperceptibly into the audio signal. These watermarks can the be extracted in case a potential infringement needs to be proven in court. [8]

In this scenario it seems to be unwise to standardise one specific algorithm because interoperability is *not* needed for these algorithms. In fact, interoperability would damage the efficiency of watermarking schemes. If different technologies are used in combination and if it is unknown which system is used in which music file, it will become increasingly complex to remove *all* watermarks that have been embedded. This could only be managed by removing *all possible* watermarks — which would strongly impair the audio quality of the music.

4 Conclusions

This paper discussed the need for an effective intellectual property management and protection scheme in order to make "Music-on-Demand" a viable business model to all parties involved in the value chain (including authors, composers, artists as well as publishers and record labels). The paper used the Imprimatur Business Model in order to deduct some requirements for a technical Intellectual Property Management & Protection system. The most important requirement is that appliances built upon the specification need to be very easy to use to be able to overcome its strongest competitor: MP3 with no Intellectual Property Management & Protection at all. Moreover, the IPMP System needs to offer a certain level of IP protection capabilities, though not 100%.

The main part of the document gave an overview over such a system where the main ingredients are (1) digital envelopes and persistent association of meta data to the payload, (2) compression of the payload by source coding, (3) scrambling of the payload and (4) watermarking and fingerprinting.

[6]Fingerprinting is as well called transaction watermarking.

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