Digital Rights Management:

Towards a Balance between Copyright Rights and Fair Use Exceptions.

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Executive Summary

There have been several attempts pointing towards DRM schemes that better satisfy Fair Use requirements [1, 2, 3, 4]; this project explores a new approach. Based on the idealistic premise that by mimicking the physical properties that prevented piracy in the pre-MP3 world into a post-MP3 world DRM scheme it should be possible to establish a copyright infringement control paradigm that is acceptable to all; this project establishes a Fair Use friendly DRM Scheme.

It has been found that for a DRM scheme to be Fair Use friendly it has to aim to reach the following idealistic characteristics:

- The copyright holders should not be able to interfere with usage which a judge would or could rule as fair use.
- The Consumers would be able to consume the content easily and spontaneously within interoperable regimes.
- The Consumers' privacy rights would be respected, in congruence with the legislation in question.
- The Consumers should be able to purchase, replicate and distribute music at a monetary cost.
- The Consumers should be able to replicate, distribute and store music at the cost of diminished quality, slow replication and slow distribution.

However it has also been found that these characteristics alone are not enough, and therefore the DRM scheme should be implemented within the following conditions:

- The DRM scheme should find ways to handle the ambiguity of Fair Use.
- The DRM scheme should facilitate *ex-post* tracking and monitoring rather than *ex-ante* based decision making.
- The DRM scheme should support interoperability and privacy.

An example of how these properties can be implemented has been designed.

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Chapter 1: Introduction

The proliferation of the Internet, coupled with novel information technologies such as the emergence of mobile computing, peer to peer (P2P) networking and electronic mail have facilitated both the perfect replication of information, and the simple and quick transfer of information between geographically distant locations. This is vital to the flourishing of modern knowledge-based economies however it also presents threats; for example: the emergence of P2P networking and the publication of the MP3 audio data compression standard laid the foundations for the explosion of digital audio copyright infringement, and this jeopardises the extent to which copyright holders may be rewarded for their creations [5, 6].

The birth of Digital Rights Management (DRM) is the most prevalent and ubiquitous technology for the persistent protection of digital music content; and its origin is often attributed to the Music Industry's need to resist copyright infringement; however the technology often offers protection in ways that bypass the Fair Use exceptions granted by copyright law, and therefore like piracy it also jeopardises music creativity and innovation. Therefore this project aims to establish a DRM scheme which goes a step further towards the bridging of copyright rights and Fair Use exceptions in DRM.

1.1 Objectives

As abstractly represented in Figure 1.1, the project aims to propose a practical Fair Use friendly DRM scheme that reduces the gap between Copyright rights and Fair Use exceptions in DRM.

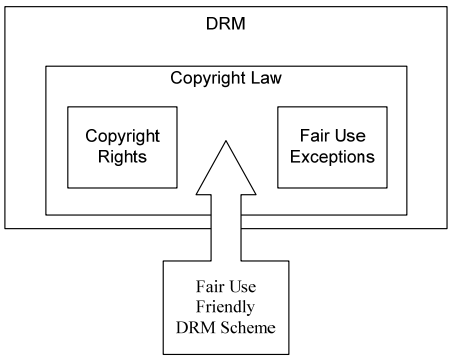

Figure 1.1: Reducing the Gap between Copyright Rights and Fair Use Exceptions

In Chapter 2 a realistic set of Fair Use friendly DRM Scheme stakeholders are identified. This is done by first establishing a context by means of a literature review which enables: the exploration of the use of schemes in DRM research, the selection of a DRM definition, the differentiation between the terms “DRM Stakeholder” and “DRM Component”, and a comparison between DRM stakeholders employed in different DRM schemes; and then identifying and justifying a set of Fair Use friendly DRM Scheme stakeholders within the context established.

In Chapter 3 a set of idealistic functionality-centric characteristics for a Fair Use friendly DRM Scheme are established.

First the basic media usage differences between the pre-MP3 world and the DRM free post-MP3 world are identified; secondly the key physical properties that used to inhibit copyright infringement in the pre-MP3 world and the properties that facilitated the proliferation of piracy in the DRM free post-MP3 world are identified; thirdly the DRM schemes presented in [7] and [8] were analysed to characterise the current state-of-the-art DRM; and finally, the key properties that limited copyright infringement in the pre-MP3 world, and the characterisation of the current state-of-the-art DRM, were compared by means of five fictitious case scenarios, to enable the establishment of the set of idealistic key functionality-centric characteristics (C1 – C5). These would mimic the pre-MP3 world copyright rights and Fair Use exception properties into a post-MP3 world DRM scheme.

Chapter 4 identifies a realistic set of Fair Use properties for a Fair Use friendly DRM Scheme which acts as restrictions for the implementation of the set of idealistic functionality-centric characteristics established in Chapter 3. It does so by: employing the previously established set of idealistic characteristics for a Fair Use friendly DRM Scheme (C1 – C5) with the aim to establish a set of seven research questions (see Section 4.2, Table 4.1); and then conducting a literature review to enable an elaborate discussion aiming to answer the identified questions. Finally the literature review essays were summarised into a set of six realistic Fair Use properties for a Fair Use friendly DRM Scheme (labelled as D1 – D6). The six properties concisely answer the questions posed in Table 4.1.

Chapter 5 establishes the design properties for the proposal of the practical Fair Use friendly DRM Scheme. It does so by considering C1 – C5 and D1 – D6; and thus the design properties reflect the functionality proposed by C1 – C5 within the restrictions proposed in D1 – D6.

Chapter 2: DRM Scheme Stakeholders

The term *scheme* is defined in [9] as "*…a body or system of related doctrines, theories, etc*…" Indeed the use of schemes is common in DRM research, and as you can see in Table 1.1 they are employed for: the representation of different DRM system concepts, the satisfaction of different requirements; and the addressing of different issues, such as: the lack of interoperability, the lack of conformance to copyright law, and the Consumers' privacy invasion. For the aim of this project a DRM scheme is established to present a novel approach for the reduction of the gap between Copyright rights and Fair Use exceptions in DRM. The purpose of this chapter is to identify a realistic set of Fair Use friendly DRM stakeholders for the mentioned DRM scheme.

In Section 2.1 a DRM definition is selected to establish the context within which this project's analyses and contributions should be interpreted; and then in Section 2.2 the selection of the project's realistic set of Fair Use friendly DRM scheme stakeholders is presented and justified.

Purpose of the Scheme	Reference/s
Classification of security architectures	[10]
Conceptualisation of DRM components	[11]
Promotion of standardisation and/or usability and/or interoperability	[12], [13], [14]
Promotion of measures that address the main security elements that give rise to content piracy	[8]
Promotion of a general approach for any DRM system	[7]
Promotion of a three dimensional perspective towards DRM, which encompasses the social, legal and technological aspects of digital copyright	[15]
Evaluation of DRM proposals	[16]

Table 2.1: The utilisation of schemes in DRM

2.1 Defining DRM

There have been several examinations of DRM, by various researchers and in different contexts, and this led to varying definitions which place DRM as a research area into different contexts. For example, on one hand it has been argued that DRM should be seen as digitally managing all the rights and not only the digital rights applicable to permissions over digital content [11]; and on the other it has been argued that DRM is about the management of digital rights [14].

Rosenblatt [17], Ianella [11], and Jamkhedkar and Heileman [14] have categorised DRM systems into two different DRM generations which represent two different scopes. There is a common agreement that: the first generation refers to the simple encryption of digital content and the limitation of its distribution only to the paying consumers, thus implying weak levels of protection; and the second generation refers to a broader scope which as defined by Rosenblatt, encompasses *"…everything that can be done to define, manage, and track rights to digital content…"*, including persistent protection and technology such as audio fingerprinting and digital watermarking which enable the management and tracking of digital content on the internet.

Since this Fair Use friendly DRM scheme proposed in this project employs digital watermarking to enable monitoring and tracking activities, it is more appropriate to select the second DRM generation definition of Rosenblatt, that is: *"…everything that can be done to define, manage, and track rights to digital content…"*

2.2 DRM Stakeholders

There is a tendency to collectively consider DRM Stakeholders and DRM System Components. Since DRM is ubiquitous and employs different stakeholders and different system components in different contexts, for the purposes of this project DRM Stakeholders and DRM System Components are considered independently. DRM Stakeholders are the groups of people with an interest in the paths taken by DRM, and DRM System Components are all the remaining DRM scheme components, including rights expression paradigms such as the XrML REL [18], the ODRL REL [19] and the DReaM-MMI protocol [20]; TTPs such as the Certificate Authority and the DRM controller proposed in [21]; cryptographic primitives,

such as the hash functions and stream ciphers mentioned in [8]; and cryptographic protocols such as those used to exchange cryptographic keys.

Current DRM literature does not provide a list of rigid stakeholders; this is partly due to the ubiquitous nature of DRM and its employment for the protection of different classes of information, perhaps also within different contexts. For example, while DRM systems for the protection of copyrighted music would be required to enforce the legal rights and satisfy the functional requirements of stakeholders such as the Music Producers and the Consumers, DRM systems for the protection of enterprise information would be required to enforce the legal rights and satisfy the functional requirements of stakeholders such as the Enterprise Management and the Employees. Another cause is that even when DRM systems are considered within similar contexts, inevitably different scholars develop different objectives and perspectives. For example, although in [22] and [15] DRM was considered for the protection of copyrighted digital content; in Table 2.2 you can see that the authors identified different DRM stakeholders.

[22]	**[15]**
Year 1999	**Year 2005**
The author	Content Developers
The right-holder (or copyright owner)	Rights Owners
The creation provider (or service producer)	Technology Providers
The media distributor (or service provider)	
	Copyright Lawyers
	Lawmakers
	Copyright Infringers
	Consumers
The IPR register or database	
The Unique Number issuer	
The controller	
The certification authority (CA)	

Table 2.2: Mapping the DRM stakeholders of [22] and [15]

Similarly, while in [21] Arnab and Hutchinson adopted the stakeholders that were identified in [22]; they added the End User stakeholder since they argued that DRM protected works are essentially subject to contracts between End Users and Rights Holders. Based on this, there were also modifications in the controller and in the Certification Authority component definitions.

2.2.1 Selecting the DRM Scheme Stakeholders

The appropriateness of the ideologies advocated by WIPO for the endorsement of innovation and creativity is not challenged or questioned in this project, however it is verified that current state-of-the-art DRM system characteristics do diverge from these ideologies, mainly because their contributions revolve around stakeholder requirements rather than around legal requirements.

Since the ultimate purpose of this project is to propose a practical Fair Use friendly DRM scheme that reduces the gap between Copyright rights and Fair Use exceptions in DRM, it is my opinion that the Fair Use friendly DRM scheme's stakeholders should be reflected into the key copyright law stakeholders; therefore, since the stakeholders identified in [15] are based on and closely related to copyright law, the scheme stakeholder selection is closely related the stakeholders identified in [15]. In Sections 2.2.1.1 – 2.2.1.8 the DRM scheme stakeholders are selected and defined; and a short discussion is presented to justify the selections.

2.2.1.1 The Music Producers

- **Definition:**

  The Music Producers develop content, may publish it, and are interested in financial or other forms of recognition incentives or returns in order to produce more.

- **Justification:**

  The Music Producers stakeholder corresponds and is in congruence both with the Content Developers stakeholder identified in [15] and with the WIPO main objectives from [27]. The recognition mentioned in this definition acts as incentive towards innovation and creativity.

2.2.1.2 The DRM Technology Providers

- **Definition:**

  The DRM Technology Providers comprise the online music stores, and the providers of DRM system components for the protection of copyrighted music content. Their interest is in maximising their profits; and they are often accused that at times they do so through business tactics that are in conflict with the interests of other stakeholders, such as the lack of interoperability.

- **Justification:**

  The DRM Technology Providers stakeholder corresponds to the Technology Providers stakeholder identified in [15]; however the scholars and researchers are not considered as DRM Technology Providers, mainly because it is recognised that the scholar's independent interest in the research and scientific aspect of the technology would differ from the DRM Technology Providers' interests, given the Technology Providers position in the value chain.

2.2.1.3 The Music Distributors

- **Definition:**

  The Music Distributors are the intermediate parties between the Music Producers and the Consumers; however they do not include the DRM Technology Providers. These usually want maximum control over all the information. The more control they exercise, the maximum profit they gain.

- **Justification:**

  The Music Distributors stakeholder indirectly corresponds to the Rights Owners stakeholder identified in [15], however while for the purposes of [15] the inclusion of the Content Developers, Distributors, Publishers, Producers, Designers and other Content Producer – Consumer intermediaries in the Rights Owners stakeholder is justified; for the purposes of this project the separation of the Music Distributors from the Music Producers, DRM Technology Providers, and perhaps also other intermediaries raises important points.

  For instance, the interests of some DRM Technology Providers may be different from those of others. Also, their interests may also be conflicting with those of the Music

Distributors. The reason behind this is that generally mainstream Music Producers sign contracts with mainstream Music Distributors who in turn market and replicate their music at international levels; consequently for online music stores such as iTunes to distribute mainstream music, they must sign agreements with the same Music Distributors. However other online music stores, such as eMusic [23], tend to provide to non-mainstream Music Producers the opportunity to distribute digital music content to the online music market [24, 25]; and this implies the supply of a wider range of music to a limited demand.

2.2.1.4 The Consumers

- **Definition:**

  The Consumers are the parties consuming the copyrighted digital music content. They want fair and easy access to content; also they want a fair law that protects their natural rights defined in the Fair Use and First Sale doctrines.

- **Justification:**

  This definition is in congruence with that presented in [15], however while it is recognised that the consumers want a fair law that protects their rights defined both in the Fair Use and First Sale doctrines, the First Sale doctrine is not directly related to the issues discussed in this project.

  The definition is also congruent both with the main objectives of WIPO, and with the INDICARE survey results [26], although the INDICARE survey results indicate that classes of users would also welcome business models that bypass the Fair Use doctrine.

2.2.1.5 The Legal Authorities

- **Definition:**

  The Legal Authorities represent the WIPO and its member countries' copyright legal authorities, whose main objectives are outlined in [27].

- **Justification:**

The Legal Authorities stakeholder corresponds to the Lawmakers stakeholder identified in [15]; however, WIPO and its member countries' legislators are explicitly identified as the Fair Use friendly DRM scheme's Legal Authorities.

2.2.1.6 The Copyright Infringers

- **Definition:**

The Copyright Infringers are those who either illegally tamper with protection devices or obtain access in an illegal manner to copyright protected content.

- **Justification:**

This definition is partly in congruence with that of [15]; however tampering with protection may not always constitute copyright infringement; for example if the intention is to use the content to achieve interoperability or within Fair Use limits.

2.2.1.7 The General Public

- **Definition:**

The General Public refers to any person with a direct or indirect interest in creativity and innovation.

- **Justification:**

The General Public is not considered as a stakeholder in any of the surveyed literature. Since DRM has the potential to jeopardise Fair Use, and since Fair Use is an important mechanism for the promotion of innovation, creativity and the evolution of copyright law, and since innovation and creativity are also beneficial to the general public, then the General Public should also be considered as a stakeholder for Fair Use friendly DRM Schemes.

2.2.1.8 General Notes

- **Note 1:**

The term Music Industry refers to the Music Producers and the Music Distributors, collectively.

- **Note 2:**

  Although in dissimilarity with [15] the Copyright Lawyers are not identified as DRM stakeholders since their involvement is outside the scope of this project, it is recognised that since DRM has the potential to jeopardise the ambiguity of Fair Use, it also has the potential to jeopardise the evolution and effectiveness of copyright law and copyright lawyers.

2.3 Conclusion

This chapter has presented the results of a literature review that enabled: the exploration of the use of schemes in DRM research, the selection of a DRM definition, the differentiation between the terms “DRM Stakeholder” and “DRM Component”, a comparison between DRM stakeholders employed in different DRM schemes, and the identification and justification of a set of Fair Use friendly DRM Scheme stakeholders.

Chapter 3: An Idealistic Set of Characteristics

Scholars, such as Priest E., argued that copyright law and DRM have failed to reward the copyright holders and that this is why there should be a shift from the traditional and subscription digital content retail models towards revenue models that embrace the openness of the internet, such as the advertising based digital content revenue model [28]. Other scholars, for example Rosenblatt, argued that copyright law should be completely replaced with more *a priori* models, such as those enforced by the currently more prevalent DRM systems [29]. Others argued in favour of less ambiguous copyright laws to facilitate the coding of decision making algorithms in DRM [30]. Yet other DRM researchers proposed technical resolutions that could minimise the gap between DRM and copyright laws. For example:

- Arnab and Hutchinson see DRM as a mechanism for enforcing license and contract restrictions on digital data between the copyright holders and the consumers, rather than a copyright law enforcing tool. However they argue that DRM does have a place in the digital distribution of copyrighted works. They proposed two technical approaches to enable the Consumers *"…to get a more balanced deal from the Rights Holders..."*. The first approach focused on extending unidirectional RELs into bidirectional RELs to enable the negotiation of licenses rather than permitting the rights holders to rigidly set up accept/decline contracts [1, 3]. The second approach focused on the granting of access on the basis of credentials [1].

- Grzonkowski S., et al. proposed a social networking based DRM scheme that finds a compromise between the Consumers and the copyright holders by implementing some restrictions from the physical world into the digital world. The scheme extends existing RELs to enable the satisfaction of a wider spectrum of fair uses based on the social network connections; however the spectrum covered does not represent all the legally allowed fair usage. In this scheme, *"…Firstly, a customer specifies a list of trusted people and devices; this allows the customer to legally transfer the file to those devices and people. However, at the same time, the file should be removed or locked at its source. Secondly, the aim of the user's social network is to notify the content provider where the currently un-locked media file is…"* [2].

- SUN Microsystems developed the DReaM-MMI protocol for the open DReaM project, which takes an approach where the Consumers are required to decide whether a use is fair or not and make a request, their decision is trusted and access is authorised, and then if the copyright holder disagrees, it enables a court to decide whether the Consumer is liable for copyright infringement or not [20, 4].

In this chapter a novel approach is taken. It is argued that idealistically, based on the premise that: the resistance to piracy prior to the publication of the MP3 standard was deemed to be acceptable by the copyright stakeholders [28]; such acceptability can be attributed to a balance between Copyright rights and Fair Use exceptions; and any changes in the stakeholders' expectations can either be negotiated or reversed; then by mimicking the pre-MP3 world physical piracy preventing properties into a post-MP3 world DRM scheme, it should become possible to establish a piracy control paradigm acceptable to all. Based on this, the establishment of an idealistic set of characteristics for a Fair Use friendly DRM Scheme that reduces the gap between Copyright rights and Fair Use exceptions in DRM would be possible. As pictorially represented in Figure 3.1 this is achieved as follows:

- In Section 3.1, first the basic media usage differences between the pre-MP3 world and the DRM free post-MP3 world are identified and then employed to identify the key physical properties that used to inhibit copyright infringement in the pre-MP3 world and that facilitated the proliferation of piracy in the DRM free post-MP3 world.

- In Section 3.2, the differences and similarities between the DRM system requirements published by Arnab in 2007 [7] and the DRM ideal scheme requirements published by Abbadi in 2008 [8] are employed to characterise the current state-of-the-art DRM.

- In Section 3.3, the key properties that limited copyright infringement in the pre-MP3 world, from Section 3.1, and the characterisation of the current state-of-the-art DRM established in Section 3.2 are put side by side by analysing their effectiveness in reducing the gap between Copyright rights and Fair Use exceptions, through the analysis of their impact on five fictitious scenarios.

- In Section 3.4 the findings of Section 3.3 are considered to establish the idealistic set of key functionality-centric characteristics that would mimic the pre-MP3 world copyright right and Fair Use exception properties.

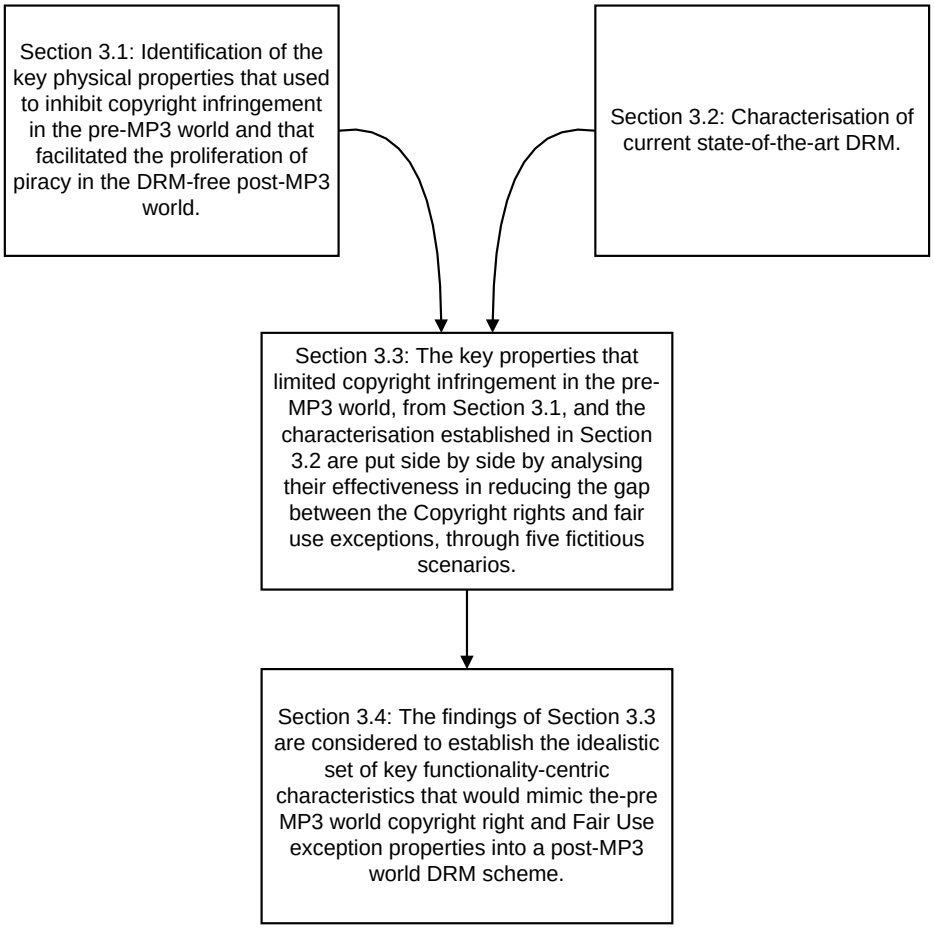

Figure 3.1: Methodology

3.1 Pre-MP3 vis-à-vis Post-MP3

In Figure 3.2 you can see the last decades' evolution of the music distribution media. The pre-MP3 world refers to the period prior to the publication of the MP3 standard and encapsulates all the means available at that time, including limited internet technologies, costly computer systems, and physical music consumption and distribution models. The post-MP3 world refers to the era subsequent to the MP3 publication which encapsulates all the means and technologies available in the present, including DRM, P2P networking, the wide adoption of internet technologies, and novel online music consumption and distribution models.

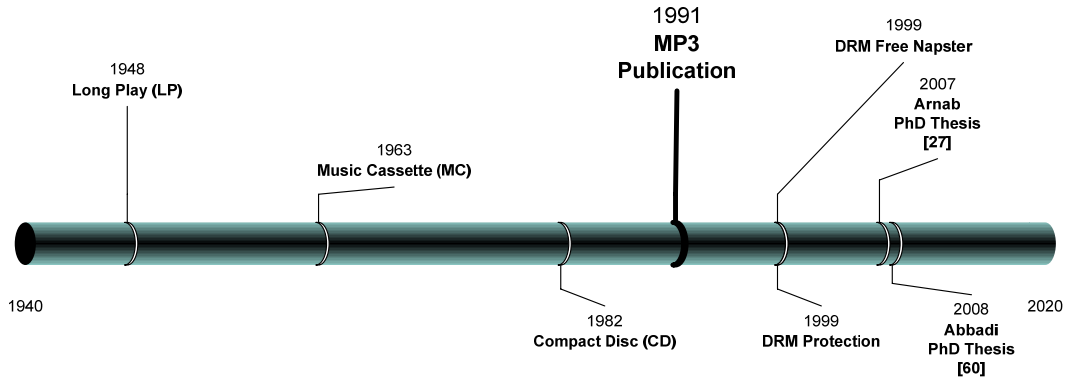

Figure 3.2: Timeline of prevalent Music Distribution Media and Technologies

Since it was the publication of the MP3 standard along with the proliferation of the internet and P2P networking that led to the explosion of copyright infringement [6], in order to identify the key media characteristics leading to such explosion, and to identify the key characteristics preventing copyright infringement in the pre-MP3 world; Section 3.1.1 identifies the key operations used for copyright infringement in the pre-MP3 world and those used in the DRM-free post-MP3 world and differs between them. Section 3.1.2 summarises the key operation characteristics preventing copyright infringement in the pre-MP3 World and those enabling copyright infringement in the DRM free Post-MP3 World.

3.1.1 Pre-MP3 vis-à-vis Post-MP3: Media Operations

As shown in Figure 3.3, in the pre-MP3 world, when copyright infringement was reasonably limited, the latest most prevalent music media were the Music Cassette (MC) and the Compact Disc (CD) [6]. For this reason the analysis of this section will identify and differ between the key operations used for infringing copyright through MCs, CDs and digital audio files, such as MP3 files.

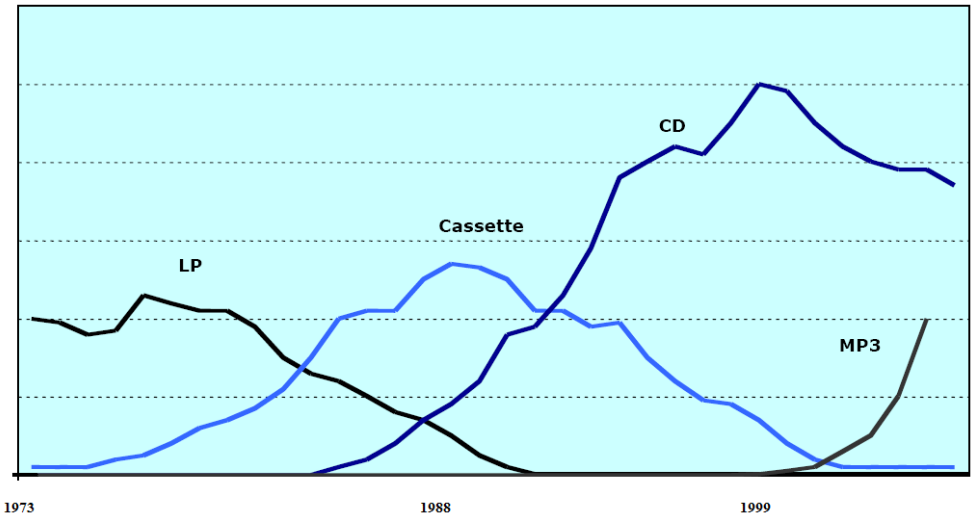

Figure 3.3: Prevalence of Music Media in the pre-MP3 World [6]

It is my opinion that, as pictorially represented in Figure 3.4, the basic operations for the conduction of copyright infringement activities through MCs, CDs and digital audio files are the replication, storage, and distribution operations. Each of these operations may be characterised by means of the speed, quality loss and cost operation characteristics.

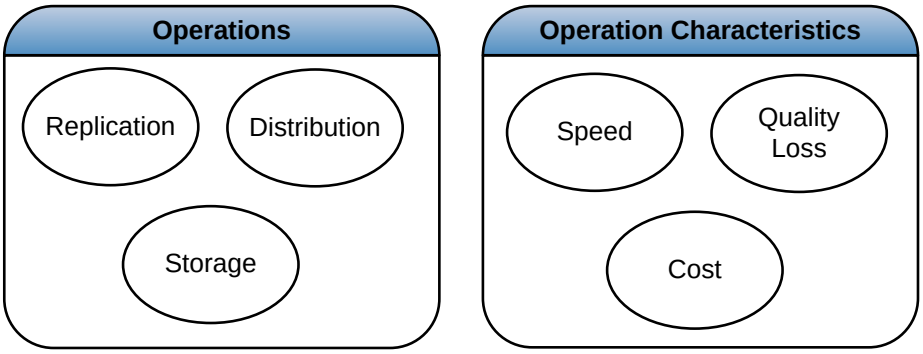

Figure 3.4: Copyright Infringement Operations and Characteristics.

In Sections 3.1.1.1 – 3.1.1.9, each of the operations is considered in terms of its characterisation in the pre-MP3 world and in the DRM-free post-MP3 world.

3.1.1.1 Replication Costs

The two key factors impacting the cost of replications to MCs and CDs in the pre MP3 world and in the post-MP3 world may be categorised into the recording device costs and into the media costs. In the US media recording devices were subject to levies due to the presumption of private copying, in accordance with the Audio Home Recording Act of 1992 (USC 17 §10). In the EU recordable media were subject to levies from electronic device makers for presumptive private copies [29].

The cost of MC recording devices varies with the quality of the audio that they can output to MC media. If high quality replication to MC media is required then unless costly MC recording devices are acquired, while the replica would still be usable, it would include high levels of what is referred to as the "hissing and humming" noise. The quality and the cost of MC recorders were generally lower and higher, respectively, in the pre-MP3 world than in the post-MP3 world. The cost of CD recording devices cannot vary much in relation to quality since the devices can produce "invariably" high quality digital audio outputs however in the pre-MP3 world CD recording devices were generally unaffordable by average Consumers. In the post-MP3 world CD and DVD rewriting devices are fifty times faster and affordable by practically all Consumers. The costs of MC and CD media also vary by their physical quality and the quality of the audio that they can store; and the cost is generally cheaper in the post-MP3 world.

In the pre-MP3 world PCs were rarely used for the replication of audio, however they were costly because the cost per audio file stored was high. In the post-MP3 world PCs are so widespread that their actual costs have both dropped drastically and are distributed amongst many uses. In addition MP3 format audio files are approximately eight times smaller than pre-MP3 world digital audio files; and Hard Disk Drives (HDDs) both have greater capacities and are cheaper in the post-MP3 world.

Therefore it may reasonably be concluded that in general, for equivalent replication quality, the replication of audio in the pre-MP3 world was considerably more expensive than it is in the post-MP3 world.

3.1.1.2 Replication Quality

In the pre and post-MP3 worlds, replication to MCs is dependent on the quality of the recording devices used and on the quality and state of the recordable media used, which are in turn dependent on the monetary investment made (see Section 3.1.1.1). Every replication induces a quality loss and therefore the extent to which music may be replicated is limited.

In the pre-MP3 world and in the post-MP3 world, the quality of digitally replicated tunes to CDs is practically identical to the source tunes; although at varying costs and speeds.

In the post-MP3 world the conversion from full quality digital audio to MP3 format digital audio does induce quality loss; however this is practically unperceivable to the human ear. Replication of MP3 files does not induce any further losses.

3.1.1.3 Replication Speed

In the pre-MP3 world the speed of replication to MCs was slow and has practically remained the same in the post-MP3 world. In the post-MP3 world the speed of replication to CD media is increased by approximately fifty times, and this is dependent on the CD recording device and on the CD media used. The replication to CD media in the post-MP3 world is still considered as slow in comparison to intra-HDD MP3 file replications. Replication of MP3 files in the post-MP3 world is faster than the replication of raw audio digital files, mainly because in general the former is eight times smaller than the latter.

3.1.1.4 Distribution Costs

The cost of physical distribution of MC and CD media in the pre and post-MP3 world was and is dependent on their physical characteristics and on the characteristics of the distribution required. The physical characteristics include their weight, fragility and dimensions. The distribution characteristics include the geographical distance travelled and the selected transportation medium.

The cost of digital distribution of digital audio files in the pre-MP3 world was dependent on whether the internet was available or not. If it was not then the digital content had to be recorded to tangible media and distributed in the conventional way. If it was, then distribution usually occurred over costly dial up connections. The data transfer rates were slow while the

file sizes were eight times larger than MP3 files. In the post-MP3 world the distribution over the internet infrastructure is greatly facilitated, and the costs incurred are “hidden”.

3.1.1.5 Distribution Quality

In the pre and post-MP3 worlds the distribution of MC and CD media was and still is subject to physical damage or loss. The distribution of digital content over the internet in a post-MP3 world is more reliable than the distribution of tangible media, especially if security mechanisms to ensure data confidentiality and data integrity, amongst other security services, are employed. The availability of data is also catered for, since for example, the internet employs packet switching capabilities.

3.1.1.6 Distribution Speed

In the pre and post-MP3 worlds the distribution speed of tangible media was and still is mainly dependent on the geographical distance and on the transport method employed. In the pre-MP3 world, the distribution of digital audio over dial up internet connections was much slower than it is in the post-MP3 world. In the post-MP3 world very high distribution speeds are possible due to the compressed nature of MP3 files, along with increased internet bandwidth, improved telecommunication protocols, and novel networking paradigms, such as P2P networking. Also in the post-MP3 world compressed digital audio files can be distributed faster in the sense that they can increasingly reach more people in less time, since the internet is more widely spread.

3.1.1.7 Storage Cost

The storage cost of a medium is dependent on the number of tunes that can be stored on the medium, and on their quality. The cost of MC, CD and HDD media in the post-MP3 world is significantly cheaper than it was in the pre-MP3 world. At the time of writing a one terabyte (TB) HDD costs £120; the price per unit storage space keeps dropping.

3.1.1.8 Storage Quality

The quality of content stored on MC, CD, and HDD media does diminish over long periods of time, especially if these are stored in environments outside the ideal temperature and humidity ranges. In the post-MP3 world, out of the three media the HDD is perhaps the best candidate in terms of the storage quality that it can enable. It can be written to and accessed in a parallel manner, at very high speeds, and at decreasing costs, thus facilitating backup systems that highly improve long term storage quality.

3.1.1.9 Storage Speed

The speed with which audio data can be written to MC, CD and HDD media is often related to the replication speeds discussed in Section 3.1.1.3, especially if this is the bottleneck preventing faster replication.

3.1.2 Pre-MP3 vs. Post-MP3: Key Media Operation Characteristics

In Table 3.1 the operation characteristics of Figure 3.4 are employed to classify the key characteristics discussed in Sections 3.1.1.1 – 3.1.1.9 into those that prevented copyright infringement in the Pre-MP3 world (Column A) and those that enable copyright infringement in the DRM free Post-MP3 world (Column B).

Operation Characteristics	Key Characteristic ID	Column A	Key Characteristic ID	Column B
Replication Costs	1 A	The need for costly recording devices and recordable media.	1 B	The costs incurred to replicate an MP3 file are negligible.
Replication Quality	2 A	Quality of replication to MC media was relatively low and dependent on monetary investments.	2 B	The replication of MP3 files does not introduce any losses.
Replication Speed	3 A	Replication was generally slow.	3 B	Replication of compressed digital audio files can occur at very high speeds. Also, replication of digital audio to CD media can be fast.
Distribution Costs	4 A	Distribution costs were high.	4 B	Music distribution occurs at very low costs.
Distribution Quality	5 A	Distribution was subject to accidental incidents.	5 B	The distribution of MP3 files does not introduce any losses.
Distribution Speeds	6 A	Generally slow distribution.	6 B	Very fast distribution of compressed digital audio is possible.
Storage Costs	7 A	Expensive storage costs.	7 B	Storage media costs per storage unit low and increasingly dropping.

Table 3.1: Key Copyright Infringement Operation Characteristics

As stated earlier, in Section 3.3 Characteristics 1A – 7A from Table 3.1, and the results of Section 3.2 shall be put side by side by analysing their effectiveness in reducing the gap between Copyright rights and Fair Use exceptions, through the analysis of their impact on the five fictitious scenarios of Section 3.3.1.

3.2 Characterising the state-of-the-art of DRM

In this section the differences and similarities between the DRM scheme requirements published by Arnab in 2007 [7] and the DRM ideal scheme requirements published by Abbadi in 2008 [8] are analysed in Sections 3.2.1 and 3.2.2, and then the results are employed to characterise the current state-of-the-art DRM in Section 3.2.3.

3.2.1 DRM protected audio files: Media Operation Characteristics

The characteristics of the media operations that can be conducted on digital audio files protected by the DRM schemes described in [77] and [8] are described in Sections 3.2.1.1 - 3.2.1.3 below.

3.2.1.1 Media Operation Characteristics: Replication

The cost, quality and speed of replication of DRM protected digital audio content are negligible, very high and very fast, respectively; however replication does not imply the possibility to consume the content; for consumption a valid license that grants access to the specific identified Consumer is required, and this implies key management requirements.

3.2.1.2 Media Operation Characteristics: Distribution

The cost, quality and speed of distribution of DRM protected digital audio content are negligible, very high and very fast, respectively; however replication does not imply the possibility to consume the content. For consumption a valid license that grants access to the specific identified Consumer is required, and this implies key management requirements.

3.2.1.3 Media Operation Characteristics: Storage

The cost of storage of DRM protected digital audio is increasingly dropping. Storage quality is very high since data backups are facilitated in the post-MP3 world. However storage of encrypted content does not imply the possibility to consume the content upon restore. To ensure the capability to consume DRM protected digital audio files the valid licenses that grant access to the specific identified Consumer should be securely backed up, therefore key management issues need to be considered.

3.2.2 Differing Between the Two DRM Schemes' Requirements

The DRM schemes' Requirements presented in [7] and [8] may be grouped into four categories and thirteen requirements, as shown in Table 3.2. In sections 3.2.2.1 to 3.2.2.13 each of the requirements is discussed in terms of the similarities and differences between the two schemes.

Category	Requirement	Requirement Code
Post Purchase Protection	Electronic revocation and update of usage rights	R1
	Usage restrictions based on time	R2
	Usage restrictions based on which devices can be used to access resources, within the same type of device and operating system	R3
	Fine grained and flexible access control	R4
	Content providers need to be able to control content consumption based on license files provided by a rights issuer	R5
	Cryptographically strong cryptographic algorithms for robust protection against attacks such as brute force, dictionary analysis, reverse engineering, etc.	R6
	Content owners need to be assured that their digital assets are protected, in order to be convinced to release their content to end user devices	R7
Privacy Issues	Private usage of content versus Tracking and monitoring the access and usage of consumers	R8
	Representation and authentication of user groups/roles, resource groups, device groups	R9
	Device and resource identification	R10
Copyright Right Exceptions	Possibility to exercise Fair Use rights	R11
Interoperability	The possibility to move content between consumer devices without requiring new licences for every device	R12
	The possibility to access content on different platforms and devices that belong to the same owner	R13

Table 3.2: DRM schemes' Requirement Grouping

3.2.2.1 Post Purchase Protection – R1:

Both Arnab [7] and Abbadi [8] advocate the requirement for the functionality to revoke rights. Abbadi points out that idealistically this functionality should be able to adapt to varying device characteristics and network connectivity properties since not all devices might be connected to the network at the same time. Arnab states that keys might need to be revoked if the Consumers violate the terms and conditions; and that there is also a requirement for the functionality that enables the updating of other access control rights, for other purposes, such as the extension of agreements beyond the stated period.

3.2.2.2 Post Purchase Protection – R2:

This is a requirement advocated in both [7] and [8]; it enables the enforcement of time based business models such as movie rental and library.

3.2.2.3 Post Purchase Protection – R3:

Arnab mentions this requirement in an explicit manner. It is also implied in [8] since if such restriction was not available, then the content would be accessible from all devices. This functionality is also required in order to exclude any compromised devices.

3.2.2.4 Post Purchase Protection – R4:

This requirement is required in both of the DRM schemes. The granularity and flexibility of access control is usually determined by the REL employed.

3.2.2.5 Post Purchase Protection – R5:

This is a requirement specified in both [7] and [8].

3.2.2.6 Post Purchase Protection – R6

This requirement is explicitly mentioned in [8]. While cryptographic strength is not mentioned by Arnab in [7], persistent protection is strongly required, and persistent protection as intended in [7] is unachievable without cryptographically strong cryptographic algorithms.

3.2.2.7 Post Purchase Protection – R7:

This requirement is explicitly mentioned in [8]. While it is not mentioned by Arnab in [7], it is assumed that the requirement is covered by the persistent protection requirement (see Section 3.2.2.6).

3.2.2.8 Privacy Issues – R8:

In both [7] and [8] the “Private usage of content” and the “Tracking and monitoring of access” requirements are identified as separate and contradictory requirements since the presence of one implies the lack of the other.

On one hand Arnab emphasises the importance of the “Tracking and monitoring” requirement and that some revocation mechanisms only work if intensive monitoring of consumer use of devices and content is possible. On the other hand he states that issues arising from such contradiction may be minimised by informing the user of what data is being collected, how the collected data is going to be used, who will have access to the collected data and how long the collected data will be stored. Arnab states that tracking and monitoring capability should only be implemented where required and with care, to ensure that monitoring and tracking are within legal parameters. He cautions that the law changes both by jurisdiction and by the type of activity that is logged.

Similarly in [8] this requirement is identified as a serious issue for end users, which may be reduced by the implementation of anonymous access. Abbadi mentions the requirement for DRM systems to conform to data protection legislation.

3.2.2.9 Privacy Issues – R9:

These are requisites in both [7] and [8].

3.2.2.10 Privacy Issues – R10:

These are requisites in both [7] and [8].

3.2.2.11 Copyright Right Exceptions – R11:

In [7] Arnab mentions the need to identify and position DRM systems and the transactions in DRM systems in a comprehensive legal framework which addresses concerns relating to copyright law and Fair Use. In [8] Abbadi mentions that a DRM system should respect either the Consumers' usage expectations or the usage rights given to them by copyright laws such as Fair Use.

3.2.2.12 Interoperability – R12:

This is a requirement in both publications.

3.2.2.13 Interoperability – R13:

Both publications mention this as a requirement. Arnab states that DRM systems should be able to support the regulation of time shifting, format shifting and space shifting, which means that the rights expression languages used should be interoperable. Abbadi refers to the same concept by stating that DRM systems should avoid platform lock-ins.

3.2.3 Characterising the Current State-of-the-Art DRM

The key replication, storage and distribution characteristics 1C – 3C for DRM systems satisfying the requirements identified in [7] and [8] are based on the discussions of Section 3.2.1 and tabulated in Table 3.3 below:

Characteristic Code	Characteristic
1C	The speed, quality and cost of replicating and distributing encrypted digital audio content are very fast, very high and very low, respectively; but encrypted content cannot be consumed unless the required cryptographic keys are available.
2C	Upon storage, the preservation of the quality of digital audio is very high, however to prevent data loss, backups are required and key management issues need to be tackled.
3C	Upon storage, digital content cost is very low, although data backups and key management issues may be required for the prevention of data loss.

Table 3.3: Key Media Operations Characteristics for State-of-the-Art DRM Systems

On the basis of Section 3.2.2, a homogeneous set of characteristics 4C – 10C for the protection of copyrighted digital content, which represents the current state-of-the-art DRM characteristics, is as shown in Table 3.4 below:

Characteristic Code	Characteristic
4C	DRM systems should be able to revoke and update usage rights, even after the purchase transaction is complete.
5C	DRM systems should be able to specify fine grained and flexible access control, including the restriction of access on the basis of time, frequency, individuals, groups or roles of people, device identifiers, device types, groups of devices, resources, and groups of resources, by means of licenses. Therefore the DRM systems should be able to represent, identify and/or authenticate time, frequency of usage, individuals, user groups and roles, resources and resource groups, and devices and device groups.
6C	DRM systems should employ cryptographically robust cryptographic algorithms, to ensure that the digital content is protected consistently in conformance to usage licenses, and to assure the content owners that the content may be released.
7C	DRM systems should enable tracking and monitoring, but this has to be done within legal parameters, therefore it may not be possible to implement the functionality for all contexts and in all countries. When such mechanisms are implemented, due to privacy issues, the systems should comply with data protection legislation, and the users should be aware of what data is being collected, how it is used, who has access to the data, and for how long it will be stored.
8C	DRM systems should be able to enable anonymous access.
9C	DRM systems should enable fair use and meet the Consumers' expectations.
10C	DRM systems should promote interoperability by enabling the Consumers to move content between devices without requiring new licenses for every device, and by enabling the access of content on different platforms and devices that belong to the same owner.

Table 3.4: Homogeneous Set of Characteristics which represents the current state-of-the-art DRM

3.3 Evaluating 1A – 7A and 1C – 10C

Since piracy in the post-MP3 world presents a bigger problem than it presented in the pre-MP3 world, this section takes five case scenarios (see Section 3.3.1) and analyses them in two different settings. The first setting goes back to the pre-MP3 world, where the characteristics 1A – 7A from Section 3.1.2 were the key characteristics limiting copyright infringement and enabling Fair Use. The second setting being in the post-MP3 world under the protection of state-of-the-art DRM, as characterised in Tables 3.3 and 3.4 of Section 3.2.3. The impact of characteristics 1A – 7A and 1C – 10C on the scenarios sheds light on the properties that should constitute an idealistic set of functionality-centred DRM characteristics (see Section 3.4).

3.3.1 The Five Comparison Case Scenarios

This section presents the selection of the five fictitious case scenarios that shall be used to evaluate the differences between the pre-MP3 world and the post-MP3 world, as outlined in the introduction of Section 3.3.

In the pre and post-MP3 worlds the Consumers and any third parties mentioned in the case scenarios have access to three PCs, a car audio device, and a high fidelity (hi-fi) system. In the post-MP3 world all the parties also own a portable music player.

In the pre-MP3 world the PCs are not internet connected, run Microsoft Windows operating systems, and are equipped with a CD reader, and an average quality MC player and recorder. The car audio devices may play MC media and audio CD media. The hi-fi systems can play CD media and MC media, and can record any played audio to MC media, at a cost, and at relatively significant quality losses, when compared to MP3 file replications.

In the post-MP3 world the PCs run Microsoft Windows operating systems and are equipped with DVD/CD reading and rewriting devices. The portable players are DRM enabled. The car audio devices may play MC media, audio CD media and MP3 files. The hi-fi systems can play CD media, MC media and any non DRM protected MP3 files; they can also record and play audio to MCs at a cost and at relatively significant quality losses, when compared to MP3 file replications.

	Scenario Details	Legal Note
Scenario 1	Bob legally purchases a tune and shares it with his brother Mark who lives in the same house but owns his own equipment, for entertainment purposes.	It is assumed that this use would be ruled as fair use by the Legal Authorities since the shared copy is neither for commercial purposes and nor shared for copying [31].
Scenario 2	Karen legally purchases a tune and reverses and adds a couple of sound effects to a small part of the song for educational purposes.	It is assumed that this use would be ruled as fair use by the Legal Authorities [31].
Scenario 3	Roberto, residing in London, legally purchases a tune and wants to be able to consume it on all his devices and to temporarily share it with his friend Alice, who lives in the US, for entertainment purposes.	It is assumed that this use would be ruled as fair use by the Legal Authorities since it is neither for commercial purposes and nor shared for copying [31].
Scenario 4	Lupin the 3rd legally purchases a tune and wants to re engineer the song for mass replication and mass distribution in the US and Europe for profit purposes. Lupin believes that such activity does not infringe copyright in these regions.	It is assumed that whether this is a fair use cannot be predetermined by a copyright consulting lawyer, and that therefore Lupin is taking a legal risk.
Scenario 5	Black Jack legally purchases a tune and wants to mass replicate and distribute it to the US and Europe for profits.	It is known that this use would be ruled as copyright infringing by the Legal Authorities, and Black Jack knows it.

Table 3.5: Five Comparison Scenarios and their Legality

3.3.2 Analysis of 1A – 7A in terms of the Five Scenarios

In Sections 3.3.2.1 – 3.3.2.6 each of characteristics 1A – 7A that were identified in Table 3.1 (see Section 3.1.2) as the key characteristics limiting copyright infringement and encouraging

Fair Use in the pre-MP3 world, is discussed in terms of the five scenarios of Table 3.5. From this discussion a set of key properties of characteristics 1A to 7A are then elicited and presented in Section 3.3.2.7.

3.3.2.1 Discussion of the 5 Scenarios in terms of Characteristics 1A - 2A

1A: *"...The need for costly recording devices and recordable media..."*

2A: *"...Quality of replication to MC media was relatively low and dependent on monetary investments..."*

The two characteristics had an impact on all scenarios. In the case of Scenarios 1 and 2, which are deemed to be within the legal Fair Use parameters, the Consumers could either use average quality MC recording devices and media at average costs to obtain average quality replicas, or else if higher quality was preferred, then higher quality recording devices and media were necessary and could be purchased at higher costs. The former option was generally satisfactory for domestic uses and therefore it could easily be preferred over the latter. The latter would only be financially feasible if enough replications were required to justify the extra expense; otherwise the purchasing additional original copies would be more viable. In any case the Consumer was not obtaining the second copy for free; most probably levies were paid either on the recording devices, on the empty media, or perhaps on both (see Section 3.1.1.1).

In the case of Scenario 3 the same issues still applied, but any replication costs had to be considered together with any costs incurred to distribute the content from London to the US. The sum of the costs was likely to render the activity financially infeasible since the purchasing of original copies from the US could be cheaper, less risky and simpler.

In the case of Scenarios 4 and 5 the same issues as for Scenarios 1 and 2 still applied, however on a larger scale. Lupin and Black Jack could either opt for average quality or for high quality replication; however in both cases the investments required were considerable and had to be done before the replicas were actually dispatched for acquirement and consumption by the Consumers. Any investments were risky since the activities were either potentially illegal or certainly illegitimate; therefore the involvement of Media Distribution companies was either impossible or difficult to secure. The number of recording devices required for replications varied by the supply of media that Lupin and Black Jack wanted to

be able to generate. If average quality replications were opted for, then this would lead to Consumer dissatisfaction, since media purchases would occur at a cost and the reduction in quality would prevent the effective replication and fair consumption. Such dissatisfaction would certainly impede Lupin and Black Jack from performing their activities.

All this points to one direction; characteristics 1A and 2A do allow fair use in all scenarios; however they pose significant barriers in Scenarios 4 and 5, where the activities are potentially illegal and certainly illegitimate, respectively. In the case of Scenario 4, if a court ruling is made and the use is deemed legal, then much of the physical barriers still remain, but at reduced business and legal risks. Since profits would be expected then the scenario becomes a normal business scenario, where investments and risks constitute the norm.

3.3.2.2 Discussion of the 5 Scenarios in terms of Characteristic 3A

3A: "...Replication was generally slow..."

This characteristic had an impact on all scenarios. In the case of Scenarios 1, 2 and 3, which are deemed to be within the legal Fair Use parameters, while the tunes' replication would be slow, since only one or a few copies were required, then speed would not highly impact the activities.

In the case of Scenarios 4 and 5, Lupin and Black Jack had three main options to increase speed. The first two options refer to the purchasing of high speed replication devices, and to the purchasing of more devices to enable parallel replications. The third option refers to the employment of a Music Distribution company. In all of the three options the investment required was considerable and had to be done before the replicas were actually dispatched for acquirement and consumption by the Consumers. Any investments were risky since the activity was either potentially illegal or certainly illegitimate; therefore the involvement of Media Distribution companies was either impossible or difficult to secure. Low speed replication could lead to a competitive disadvantage, especially for Black Jack who was directly competing with the legitimate copyright holders. Such dissatisfaction would certainly impede Lupin and Black Jack from performing their activities.

Therefore characteristic 3A did allow fair use in all scenarios; however it posed significant barriers in Scenarios 4 and 5, where the activities were potentially illegal and certainly illegitimate, respectively. In the case of Scenario 4, if a court ruling was made and confirmed the activity as legal, then some barriers still remained, but at reduced business and legal risks.

Since profits would be expected then the scenario would become a normal business scenario, where investments and risks would constitute the norm.

3.3.2.3 Discussion of the 5 Scenarios in terms of Characteristic 4A

4A: "...Distribution costs were high..."

Characteristic 4A did not impact Scenarios 1 and 2 since there was no distribution to be made. Scenario 3 was impacted since the distribution from London to US was likely to be costly. As discussed in Section 3.3.2.1, for Scenario 3 the distribution costs, along with the replication costs could make the sharing between Roberto and Alice less feasible than the purchasing of original copies from the US.

Scenarios 4 and 5 were impacted since the space taken and the weight of MC and CD media were considerable. The costs contributed towards increasing the cost of the end products and thus they exerted more pressure on the need to satisfy the Consumers' quality expectations.

Therefore characteristic 4A negatively impacted Scenario 3, which is deemed to be fair use. Whether this should or not be the case is subjective; however it was impossible to avoid in the pre-MP3 world, given the equipment available for this scenario. In the post-MP3 world the distribution costs may be reduced since the administration costs are not as high as the costs incurred to physically transfer media.

3.3.2.4 Discussion of the 5 Scenarios in terms of Characteristic 5A

5A: "...Distribution was subject to accidental incidents..."

The likelihood that Scenarios 1 and 2 would be impacted by characteristic 5A was low. The characteristic was also likely to pose risks on Scenarios 3, 4 and 5; however the materialisation of the risk on Scenarios 4 and 5 was likely to pose more damages than it would have posed in Scenario 3. Since Scenario 4 could be illegitimate, and Scenario 5 was illegal, then the materialisation of such risks would probably require absorption by Lupin or Black Jack and any Music Distributors who would have been backing the activities.

3.3.2.5 Discussion of the 5 Scenarios in terms of Characteristic 6A

6A: "...Generally slow distribution..."

Scenarios 1 and 2 were not likely to be impacted since the distribution distance was likely to be short. Scenario 3 could or could not be impacted, depending on Alice's expectations. Scenarios 4 and 5 might or might not be impacted, depending on the demand for the distributed media. The risk in Scenario 5 was higher since any unsatisfied demand was likely to be fulfilled by genuine music distribution.

3.3.2.6 Discussion of the 5 Scenarios in terms of Characteristic 7A

7A: "...Expensive storage costs..."

Scenarios 1, 2 and 3 were not highly impacted since only one or few replications were likely to be made. Scenarios 4 and 5 were likely to be impacted since the quantity of media stored was likely to be high, and since the maintenance of the media quality would have required the implementation of environmental controls.

3.3.2.7 The key properties of characteristics 1A to 7A

Table 3.6 presents the elicitation of the key properties of characteristics 1A to 7A, from Sections 3.3.2.1 – 3.3.2.6 that used to limit copyright infringement and to enable fair use in the pre-MP3 world.

Property P1	The characteristics did not hinder the fair usage Scenarios 1, 2 and 3 but this was at the cost of diminished quality, slow replication, slow distribution and/or expensive recording devices and recordable media which have greatest impact on Scenarios 4 and 5. Said this, at times the characteristics could render fair usage Scenario 3 unfeasible (see Sections 3.3.2.3 - 3.3.2.5).
Property P2	The characteristics are generally anti-copyright infringement, with greatest impact on Scenario 5. Some of the characteristics may present friction when activities such as those of Scenario 4 may or may not legally constitute fair use and at the same time seek profits through mass replication. Such friction could be minimised to normal business investment levels when and if the activities are deemed by court to constitute fair use.

Table 3.6: Impact of Characteristics 1A to 7A on the 5 Scenarios

3.3.3 Analysis Characteristics 1C – 10C in terms of the 5 Scenarios:

In Sections 3.3.3.1 – 3.3.3.10 each of the homogeneous set of characteristics for the protection of copyrighted content identified in Section 3.2.3, which represents the current state-of-the-art DRM, is analysed in terms of the five Scenarios of Table 3.5. The key impacts the characteristics on the capability of the five scenarios' parties to exercise their Fair Use exception rights while respecting the copyright holders' copyright rights are then presented in Section 3.3.3.11.

3.3.3.1 Discussion of the 5 Scenarios in terms of Characteristic 1C

1C: *"…The speed, quality and cost of replicating and distributing encrypted digital audio content are very fast, very high and very low, respectively; but encrypted content cannot be consumed unless the required cryptographic keys are available…"*

These characteristics would impact Scenarios 1, 2 and 3 positively if the functionality is allowed by the copyright holders; however if this functionality is prevented, then no matter how good the replication is, the usage would be prevented. Scenario 4 is not likely to be permitted to re engineer the music since the audio file is likely to be encrypted. The capture and storage of plaintext would be considered as circumvention and since tracking and monitoring mechanisms are likely to be in place, any circumvention could be tracked back to Lupin and actions would be subject to legal consideration. Black Jack in Scenario 5 is not likely to be permitted to mass replicate the digital audio content. If this occurs either through the analogue hole or by capturing the plaintext version of the digital audio, then the tracking and monitoring mechanisms, such as digital watermarks, are likely to enable the tracking of Black Jack, and this poses legal penalties.

3.3.3.2 Discussion of the 5 Scenarios in terms of Characteristic 2C

2C: *"…Upon storage, the preservation of the quality of digital audio is very high, however to prevent data loss, backups are required and key management issues need to be tackled…"*

The storage of high quality digital audio content is a good property. While storage of content in the pre-MP3 world was straight forward and enabled access to anyone getting hold of the

music; in the post-MP3 world the storage of encrypted content can at best grant access to the Consumers having access to a valid license. Therefore in Scenarios 1 to 3 accesses could or could not be granted, depending on the copyright holders' policy. In Scenario 4 the probability is that both the re engineering and the mass replication functions would be denied by the copyright holders. In Scenario 5 the mass replication would almost certainly be denied.

3.3.3.3 Discussion of the 5 Scenarios in terms of Characteristic 3C

3C: *"…Upon storage, digital content cost is very low, although data backups and key management issues may be required for the prevention of data loss…"*

The cheap storage of high quality digital audio content is a good property; however as for the characteristic of section 3.3.3.2 access is only granted in the post-MP3 world the storage of encrypted content can at best grant access to the Consumers having access to a valid license. In Scenarios 1 to 3 accesses could or could not be granted, depending on the copyright holders' policy. In Scenario 4 the probability is that both the re engineering and the mass replication functions would be denied by the copyright holders. In Scenario 5 the mass replication would almost certainly be denied.

3.3.3.4 Discussion of the 5 Scenarios in terms of Characteristic 4C

4C: *"...DRM systems should be able to revoke and update usage rights, even after the purchase transaction is complete…"*

The capability to revoke rights, even after the transaction is complete, may or may not negatively impact Scenarios 1 to 3, depending on the copyright holders' policy. If Lupin and Black Jack of Scenarios 4 and 5 exploit the analogue hole then any key revocations will not impact their use; however if monitoring and tracking mechanisms are in place, then such activities could be tracked back to Lupin and Black Jack. While in Scenario 4 Lupin might or might not be found guilty of DRM circumvention, re engineering or mass distribution; in Scenario 5 Black Jack would be found guilty and legal actions against him would be possible, although there exist defences which Black Jack could opt for, such as claiming that the encrypted version of the digital content and the decryption key were stolen by a third party.

3.3.3.5 Discussion of the 5 Scenarios in terms of Characteristic 5C

5C: *"...DRM systems should be able to specify fine grained and flexible access control, including the restriction of access on the basis of time, frequency, individuals, groups or roles of people, device identifiers, device types, groups of devices, resources, and groups of resources, by means of licenses. Therefore the DRM systems should be able to represent, identify and/or authenticate time, frequency of usage, individuals, user groups and roles, resources and resource groups, and devices and device groups..."*

Scenarios 1, 2 and 3 may or may not be impacted negatively, depending on the copyright holders' policy and on their requirements. Scenarios 4 and 5 are likely to be disallowed, although they can still recur to the analogue hole and possibly other circumvention techniques which would increase their legal risk.

3.3.3.6 Discussion of the 5 Scenarios in terms of Characteristic 6C

6C: *"...DRM systems should employ cryptographically robust cryptographic algorithms, to ensure that the digital content is protected consistently in conformance to usage licenses, and to assure the content owners that the content may be released…"*

The employment of cryptographically robust cryptographic algorithms implies that any DRM protection is difficult to break through cryptographic attacks, and this is likely to impact all scenarios if the intention of the relevant parties is to break the cryptographic protection; however the fact is that there are simpler attacks that could break DRM protection, such as analogue hole attacks or the capturing of decrypted digital audio streams.

Said this, security breaches through the analogue hole or through the digital audio stream capturing are not likely to effectively overcome any protection provided by digital watermarks, if these are [32]:

- Unobtrusive
- Robust to:
    - Common signal processing
    - Subterfuge attacks: Collision and Forgery
- Universal

- Unambiguous

Nonetheless, as stated in Section 3.3.3.4 defences for malice users could still exist. For instance the attackers could claim that the encrypted version of the digital content and the decryption key were stolen by a third party, and that therefore they cannot be legally liable for copyright infringement.

3.3.3.7 Discussion of the 5 Scenarios in terms of Characteristic 7C

7C: *"…DRM systems should enable tracking and monitoring, but this has to be done within legal parameters, therefore it may not be possible to implement the functionality for all contexts and in all countries. When such mechanisms are implemented, due to privacy issues, the systems should comply with data protection legislation, and the users should be aware of what data is being collected, how it is used, who has access to the data, and for how long it will be stored..."*

Whether any of the scenarios is impacted is dependent on whether the parties in questions will have circumvented the DRM system. This is because if the system is not circumvented, then only the allowed access is possible, and therefore any monitoring and tracking would not identify any usage which is unwanted by the copyright holders.

In all scenarios, the monitored and tracked parties suffer an extra level of invasion into their privacy and this may impact the scenarios.

A problem with this characteristic is that it may be difficult to implement. For instance, the monitoring and tracking of watermarked but decrypted digital content may become impossible since it would be possible to consume the content on any online or offline DRM free devices.

3.3.3.8 Discussion of the 5 Scenarios in terms of Characteristic 8C

8C: *"...DRM systems should be able to enable anonymous access…"*

Anonymous access implies more privacy, and this impacts all scenarios positively in the sense that the parties involved are not discouraged from exercising their Fair Use rights. However in the case of Scenarios 4 and 5 such rights could then be abusing the copyright holders' copyright rights. Said this, anonymous access does not necessarily constitute no monitoring and no tracking.

3.3.3.9 Discussion of the 5 Scenarios in terms of Characteristic 9C

9C: "...DRM systems should enable fair use and meet the Consumers' expectations…"

This characteristic would impact Scenarios 1, 2 and 3 positively. Scenario 4 would initially be impacted positively, until a negative legal ruling occurs. Scenario 5 would be impacted positively until the time when copyright infringement will occur.

3.3.3.10 Discussion of the 5 Scenarios in terms of Characteristic 10C

10C: "...DRM systems should promote interoperability by enabling the Consumers to move content between devices without requiring new licenses for every device, and by enabling the access of content on different platforms and devices that belong to the same owner..."

This characteristic is likely to positively impact Scenarios 1, 2 and 3 since the Consumers could agree on sharing device licenses. Scenario 4 is likely to be impacted positively since interoperability implies increased re engineering functionality. Scenario 5 is likely to be impacted positively if interoperability introduces loopholes into the DRM system.

3.3.3.11 Key state-of-the-art DRM properties

The key impact of characteristics 1C to 10C (from Sections 3.3.3.1 – 3.3.3.10) on the capability of the five scenarios' parties to exercise their Fair Use exception rights while respecting the copyright holders' copyright rights are presented in Table 3.7 below.

Impact Type	Property Number	Property
Negative impact on Fair Usage scenarios:	1	The copyright holders can interfere with the Consumers' capability to use the digital content fairly, since they control the licenses and the cryptographic keys. This may have a negative impact on the consumers' ability to exploit their Fair Use rights, in all scenarios.
	2	Since already granted fair usage permissions may be revoked by the copyright holders without the requirement of court rulings, the Consumers' ability to exploit their Fair Use rights can be negatively impacted, in all scenarios. The copyright holders' opinion on what constitutes fair use is often different from the Consumers' opinion. The Legal Authorities opinion is the only authoritative one.
	3	Depending on the copyright holders' policies, the Consumers may or may not be allowed to use their content spontaneously. Access may be granted or denied on the basis of time, frequency, individuals, groups or roles of people, device identifiers, device types, groups of devices, resources, and groups of resources. This may have a negative impact on the Fair Use rights excretion of all scenarios.
	4	In all scenarios a certain level of Consumers' privacy is infringed due to monitoring and tracking mechanisms.
Positive impact on Fair Usage scenarios:	5	Interoperability is promoted and thus the capability to consume the digital content on devices with different functionalities is encouraged.
	6	Limitations on privacy infringement are encouraged, although it is recognised that privacy must be invaded, to a certain extent, in order to be able to control copyright infringement. This is in congruence with [2].
Negative impact on Copyright breaching scenarios:	7	Illegal usage may be prohibited by the copyright holders, since they control the licenses and the cryptographic keys. This has greatest impact on Scenario 5.
	8	Permissions may be revoked by the copyright holders. This has greatest impact on Scenario 5.
	9	Access may be granted or denied on the basis of time, frequency, individuals, groups or roles of people, device identifiers, device types, groups of devices, resources, and groups of resources.
	10	Cryptographic robustness is required; however in certain circumstances this is subject to breaches through the analogue hole and other simplistic attacks, and thus enabling copyright infringement without the need to break cryptographic algorithms.
Positive impact on Copyright breaching scenarios:	11	The effectiveness of tracking and monitoring mechanisms is limited by privacy legislation and other technical factors, such as, the inability to monitor and track the usage of circumvented plaintext if this is consumed on DRM free devices. This is most beneficial to Scenario 5, for example by facilitating illegal distribution in places where the law prevents monitoring of digital content usage.

Table 3.7: Impact of Characteristics 1C to 10C on the Five Scenarios

3.4 Establishment of an Idealistic set of Characteristics for a Fair Use Friendly DRM Scheme

In Sections 3.3.2 and 3.3.3 the five fictitious scenarios of Section 3.3.1, which are a combination of fair and unfair uses, have been analysed: in terms of the Characteristics 1A – 7A, which prevented Copyright infringement in the pre-MP3 world; and in terms of characteristics 1C – 10C which represent the current state-of-the-art DRM. From these analyses it was possible to identify those characteristics endorsing and those hindering the balance between copyright rights and Fair Use exceptions (see Sections 3.3.2.7 and 3.3.3.11). Based on such results, it is concluded:

- That idealistically, the promotion of Fair Use exceptions in DRM systems requires that:

  C1: The copyright holders would not be able to interfere with usage which a judge would or could rule as fair use, since as shown in properties 1, 2 and 3 of Table 3.7 this was one of the major causes interfering with Scenarios 1 to 4.

  C2: The Consumers would be able to consume the content easily and spontaneously within interoperable regimes. Such consumption would include the fair replication, distribution and storage of music. This is in congruence with how the content was used in the pre-MP3 world, thus leading to the properties of Table 3.6.

  C3: The Consumers' privacy rights would be respected, in congruence with the legislation in question. This implies a level of privacy infringement which is higher than that incurred by the Consumers in the pre-MP3 world; however it is recognised as necessary in a post-MP3 world (see Table 3.7 Property 6).

- That idealistically, the discouragement of copyright rights infringement in DRM systems requires that:

  C4: The Consumers purchase, replicate and distribute music at a monetary cost.

C5: The Consumers replicate, distribute and store music at the cost of diminished quality, slow replication and slow distribution. This is in congruence to how the content was used in the pre-MP3 world, thus leading to the properties of Table 3.6.

3.5 Conclusion

In this Chapter a set of idealistic DRM characteristics for the promotion of a balance between copyright rights and Fair Use exceptions has been derived on the basis of the premise that by mimicking the pre-MP3 world music media operation characteristics into a post-MP3 world DRM scheme, it should become possible to establish a piracy control paradigm that facilitates the bridging of the gap between the copyright rights and the Fair Use exceptions in DRM.

The five fictitious scenarios' analyses in terms of the characteristics preventing copyright infringement in the pre-MP3 world and in terms of the current state-of-the-art DRM were crucial to the idealistic set of scenarios derivation. It is important to note that since the five fictitious scenarios do not cover all the possible Fair Use scenarios, then the derived idealistic scenarios are not based on the widest range of capabilities offered by the Fair Use doctrine. The generality of this methodology, along with the contributions of chapter 4 provide a good basis for the proposal of a practical DRM scheme in Chapter 5.

Chapter 4: A Review on Fair Use Issues

Chapter 3 sheds light on which pre-MP3 world characteristics used to enable the reduction of the gap between copyright rights and Fair Use exceptions, and on which post-MP3 world state-of-the-art DRM scheme characteristics tend to impact Fair Use exceptions and Copyright rights positively or negatively. Based on that, Section 3.4 identifies a set of functionality-centric idealistic characteristics for a Fair Use friendly DRM Scheme. Therefore essentially, Chapter 3 identifies which characteristics are pro-Fair Use and which characteristics are not; however it does not identify why those characteristics are, or are not, pro-Fair Use or not and therefore it does not induce full confidence in the design of a new Fair Use friendly DRM scheme proposal.

In view of this, this chapter explores the nature of Fair Use and identifies a realistic set of Fair Use properties for a Fair Use friendly DRM Scheme which is expected to compliment the characteristics identified in Chapter 3. Therefore while Chapter 3 determines the functionalities that should be embedded into a Fair Use friendly DRM scheme, Chapter 4 determines within which restrictions this functionalities can occur.

In Section 4.1 the Fair Use doctrine is introduced; and then in Section 4.2, the key Fair Use issues of relevance are explored into more detail. Section 4.3 summarises the chapter's findings.

4.1 Introduction to Fair Use

Most countries' intellectual property legislation is split into the Industrial Property and Copyright law branches and is regulated by the World Intellectual Property Organisation (WIPO), a United Nations specialised agency administering amongst other treaties, the WIPO Copyright Treaty (WCT) and the WIPO Performances and Phonograms Treaty (WPPT) [27]. Fair Use is a concept recognised and included into the copyright laws of WIPO member countries, such as the UK and the US, however not all countries use the same term for the concept; for example, while the US refers to the principle as the Fair Use doctrine, the UK refers to it as Fair Dealing.

The ideology of WIPO may be summarised by quoting the following two objectives [27]:

Objective 1: *"…To give statutory expression to the moral and economic rights of creators in their creations and to the rights of the public in accessing those creations…"*

Objective 2: *"…To promote creativity, and the dissemination and application of its result, and to encourage fair trade, which would contribute to economic and social development…"*

In line with these objectives WIPO normally gives a set of copyright rights to authors, and a set of copyright limitations to balance the authors' rights with the interests of other stakeholders. The authors' rights normally comprise the rights of reproduction, distribution, rental and importation; the rights of public performance, broadcasting, communication to the public, and making available to the public; the rights of translation and adaptation; and moral rights. The limitations of these rights usually include: the exclusion of certain categories of works; free use; non-voluntary licenses; free use for reproduction; and in some countries, Fair Use [27].

4.1.1 Fair Use in the United States

The following is an excerpt showing the Fair Use copyright limitation as expressed in section 107 of the DMCA.

"…§ 107. Limitations on exclusive rights: Fair use

Notwithstanding the provisions of sections 106 and 106A, the fair use of a copyrighted work, including such use by reproduction in copies or phonorecords or by any other means specified by that section, for purposes such as criticism, comment, news reporting, teaching (including multiple copies for classroom use), scholarship, or research, is not an infringement of copyright. In determining whether the use made of a work in any particular case is a fair use the factors to be considered shall include —

(1) the purpose and character of the use, including whether such use is of a commercial nature or is for nonprofit educational purposes;

(2) the nature of the copyrighted work;

(3) the amount and substantiality of the portion used in relation to the copyrighted work as a whole; and

(4) *the effect of the use upon the potential market for or value of the copyrighted work.*

The fact that a work is unpublished shall not itself bar a finding of fair use if such finding is made upon consideration of all the above factors…."

These factors are normally referred to as "the DMCA four factor test".

4.2 Fair Use Issues

As shown in Table 3.7, one major issue with current DRM schemes is that the copyright holders can interfere with the Consumers' capability to use the digital content fairly, since they control the licenses and the cryptographic keys. One possible way to eliminate this problem, and thus satisfying the idealistic characteristic C1 of Section 3.4, could have been the design of an automated process that enables the determination of whether usages are fair or unfair without the involvement of the Music Industry, and this would have greatly simplified matters for everyone. However as shown in Section 4.2.1 this is not possible since Fair Use is ambiguous; therefore as shown in Sections 4.2.2 and 4.2.3 the issue becomes one of tradeoffs between the importance of Fair Use ambiguity and the importance of the requirements posed by the relevant copyright stakeholders.

From Table 3.7 another major Fair Use related issue posed by current DRM schemes is their capability to predetermine fine grained access control licenses, since this diminishes the Consumers' capability to consume content in a spontaneous manner. To address this issue Section 4.2.4 expounds on the differences between *ex-ante* based and *ex-post* based DRM and their relation with the Fair Use doctrine.

One of the idealistic state-of-the-art DRM factors that have been identified as promoting Fair Use, in Table 3.7, is the promotion of DRM interoperability. However DRM interoperability is one of the major barriers in current *ex-ante* based DRM systems. Sections 4.2.5 and 4.2.7 discuss the link between DRM interoperability, the Fair Use doctrine, the DMCA circumvention rules and a possible shift from *ex-ante* based DRM to *ex-post* based DRM.

Another issue identified in Table 3.7 is the contradiction between the requirement for privacy, and the requirement for copyright infringement control. On one hand, Property 4 states that in

current state-of-the-art DRM schemes the Consumers' privacy is infringed due to monitoring and tracking mechanisms. On the other, Property 11 states that the effectiveness of tracking and monitoring mechanisms is limited by privacy legislation. Section 4.2.6 confirms the importance of privacy for Fair Use and shows how a shift from real *ex-ante* based DRM to real *ex-post* based DRM might impact the Consumers' privacy.

A summary of these issues and the Sections within which they are addressed is available in Table 4.1 below.

Section	Issue addressed
4.2.1	If fair/unfair use decision making is unambiguous, then an algorithm can be designed and incorporated into a DRM scheme to determine whether a use is fair or not, and this would greatly simplify matters for all. But is this the case?
4.2.2	How important is the ambiguity of Fair Use?
4.2.3	Since Fair Use is ambiguous, then should it become more rigid, or should DRM become more elastic? Who should decide?
4.2.4	Current state-of-the-art DRM is essentially *ex-ante* based. Does this imply a deviation from Fair Use?
4.2.5	Is there a relationship between Fair Use and interoperability?
4.2.6	Is there a relationship between Fair Use and privacy?
4.2.7	Is DRM circumvention for the purpose of interoperability legal? If yes, then what are the implications?

Table 4.1: Fair Use Issue Questions

4.2.1 The Ambiguity of Fair Use

"…Since the doctrine is an equitable rule of reason, no generally applicable definition is possible, and each case raising the question must be decided on its own facts..." cautioned the United States Supreme Court, in *Harper & Row, Publishers, Inc. v. Nation Enterprises (1985)*.

The same still applies in 2008; the DMCA four factor test suggests that the fair/unfair use decision process is an ambiguous one [33, 34, 35, 36]; in fact many argue that it is beyond the reach of artificial intelligence (AI) [33, 34], for example, Felten stated that should such formulation ever happen then the algorithm would perhaps constitute *"…a judge on a chip…"* [33]; and this would not only be technically infeasible but possibly also politically, socially and economically premature.

Felten also argued that should an AI algorithm be able to take decisions based on the four factor test, it would still require the input of knowledge about the circumstances which would be very difficult or impossible to capture. To support the view with an example Felten mentioned the difficulty of distinguishing between two different contexts which would polarise the legality of the exact same use. Specifically he mentioned an example where the use of content which may be fair when done in a classroom, would be illegal when done in a commercial setting [33].

Based on the opinion that the ambiguity of Fair Use is an AI hard problem, many argued that the full support of Fair Use in DRM is essentially impossible [33, 34, 29]. While it is true that such decision automation is unlikely, at least in the near future, whether DRM can handle this ambiguity or not is dependent on whether the support of Fair Use in DRM requires complex knowledge capturing mechanisms and complex decision making algorithms in the first place. Therefore the question to be asked is: Does the ambiguity of Fair Use have to be formalised and encoded into algorithms for DRM to support it? Theoretically the answer is no (see Sections 4.2.3 and 4.2.4) and therefore the formation of DRM schemes that do support Fair Use is possible.

4.2.2 The Importance of Fair Use Ambiguity

The ambiguity of Fair Use often raises questions and doubts. Legal professionals are often uncertain about fair/unfair decisions until court rulings are made, and so are the Music Distributors, Music Producers, Consumers and other copyright stakeholders; nonetheless ambiguity is considered as the Fair Use doctrine's strength as it enables the evolution of copyright law, and the promotion of innovation and creativity [37, 36].

Besek J. M. argues that a statute that provided a greater certainty would inevitably be less responsive to changes in technology and to many ways in which copyright owners and users exploit their works, however *"…uncertainty is the price we pay…"* [36].

Fred von Lohmann [37], the senior attorney of the Electronic Frontier Foundation (EFF), a foundation that calls itself *"…the leading civil liberties group defending the public rights in the digital world…"* explains that since this ambiguity requires judges to apply copyright law for new seemingly unlawful technologies, then when legal disputes arise this enables the evolution of copyright law, therefore also the opportunity to legalise otherwise unlawful technologies, and this leads to innovation and creativity. The argument goes, should Fair Use be unambiguous and hard coded into DRM systems in such a way to enable automated *ex-ante* decision making such disputes would not occur in the first place. A case in point, von

Lohmann pointed out, is the *Sony Corporation of America v. Universal City Studios, Inc., 464 U.S. 417* case of 1984 [38], where in opposition to what many copyright lawyers would have concluded before the judgment, the Supreme Court of the United States ruled that the making of individual copies of complete television shows for time-shifting purposes is fair use. This meant that the manufacturers of home video recording devices, such as Betamax or other VCRs could not be liable for infringement. Subsequently this resulted into a boom to the home video market and entertainment industry.

4.2.3 Should Fair Use become more rigid? Who should decide?

The big 4 Music Distributors are currently in control of the physical music distribution market which constitutes approximately 82% of the global music market revenues [39], and this is possible because they have the ability both to promote the mainstream Music Producers' works on an international level, and to support the investments required to mass replicate music to tangible media for the supply to a global demand. Consequently, although the proliferation of the internet has provided the infrastructure required for very low cost mass distribution of music, any mainstream Music Producers holding the privilege to establish binding contracts with major Music Distributors would not opt out to be able to supply music to the digital market which constitutes only approximately 15% of the global music sales [39].

The 82% figure equips the Music Distributors with the autonomy required to decide through which of the online music stores to conduct business; this implies that the success of online music stores is dependent on the participation of the Music Distributors [30], since the Music Distributors hold the rights over music produced by the mainstream Music Producers. Therefore the Music Distributors are in a position enabling them to also control the evolution of DRM Technologies that are used for the protection of the digital music distributed online.

The online music consumers cannot do much to influence the exercising of such control. As Cohen J. E. argued, *"…market processes are not well suited to enable consumers to exert positive, as opposed to negative, influence on the design of technical standards. Consumers can refuse to buy, or can switch from one provider to another, but there are no mechanisms to allow consumers to communicate as a prospective matter the precise level of functionality that they want…"* [40].

The ambiguity of Fair Use seems to hold back the development of DRM systems that support the doctrine [33, 34, 29], and therefore the Music Industry seems to have no other option than to push forward DRM systems that employ unambiguous fair/unfair use decision making algorithms. However by so doing the Music Industry actually takes a legal alternative which bypasses copyright law; and this implies that the industry at least influences the strings that control the equilibrium between the copyright rights and the Fair Use exceptions. Therefore the choice seems to be between the ambiguity of Fair Use and the equilibrium between the Music Industry and the Consumers.

If the case truly is that this ambiguity is endangering the equilibrium, then it might become reasonable to reconsider the extent to which Fair Use should be ambiguous; however if the case is not, then the current levels of ambiguity may be maintained. Based on such reasoning, and on the fact that the ambiguity of Fair Use is considered as the strength of the Fair Use doctrine, whether Fair Use should be less ambiguous or not is dependent on the extent to which DRM can accommodate the current ambiguity of Fair Use; and this raises questions: Could the Music Industry have an interest in interfering with the extent to which DRM could support Fair Use since this gives the industry the power to influence the equilibrium between itself and the Consumers? Also, are DRM Technology Providers in a position to try hard enough to support Fair Use? If so, are they doing this?

Not only do different music distribution companies tend to develop different approaches, but the same companies tend to alter their strategies as the time passes by and the circumstances change (see Section 4.2.4.1). It seems however that the Music Industry does have the power to control to which extent current DRM systems can satisfy Fair Use requirements. Major DRM Technology Providers aiming to support mainstream Music Industry driven business models are not in a position to try harder than required by the Music Industry to support the Fair Use doctrine since their success is dependent on the mainstream Music Industry's participation [30], however the extent to which the mainstream Music Industry may be supported by the DRM Technology Providers is opposed both by the Consumers [31, 42, 43] and by non mainstream Music Producers who tend to take advantage of less popular online music stores such as eMusic which employ DRM systems that are more loyal to Fair Use [24, 25].

The Legal Authorities responsible for the socioeconomic values at stake should ensure that they, and not any of the other DRM stakeholders, are controlling the strings that maintain the path towards the flourishing of creativity and innovation. Therefore it is the Legal Authorities who should decide to which extent DRM systems could or should satisfy the Fair Use requirements. This should occur while the Legal Authorities stick to the current WIPO ideologies, and/or recur to alternative paradigms such as those mentioned in the introduction

of Chapter 3. Other stakeholders need to persist in protecting the preservation and evolution of their rights, while striving towards reaching compromises acceptable to all.

The project does not explore the extent to which Fair Use ambiguity should or could become rigid. It recognizes the real possibility of taking DRM one step closer towards the bridging of copyright rights and the current form of Fair Use exceptions through more elasticity in DRM.

4.2.4 Does *ex-ante* based DRM imply deviations from Fair Use?

Under the Fair Use doctrine the Consumer takes a legal risk by taking an *ex-ante* decision about the fairness of a usage, then if an infringement suit is brought later by the copyright holders, the court may or may not validate the user's calculus, but any penalties are imposed after the use has been made and not before [34], thus any fair/unfair usage decisions are essentially *ex-post* decisions.

The DRM systems currently pushed by the mainstream Music Industry operate under contract law [30]. Within this legal regime, whether the copyright holder considers a use by the Consumer as fair or not is predetermined in an unambiguous contract or license; then if the contract is breached by the consumer, the consumer is subject to penalties; therefore in current DRM systems, including those analysed to characterise the current state-of-the-art in Chapter 3, primarily fair/unfair usage decisions are *ex-ante* based decisions. It is recognised that the development of DRM systems that support only *ex-post* decision making is possible; therefore for the purposes of this project DRM systems are categorised into *ex-ante* based and *ex-post* based DRM systems.

Ex-ante based DRM systems express fair/unfair usage decisions in an *ex-ante* manner by means of contracts. In addition they control access to digital content on the basis of such decisions in such a way that minimises the Consumer's ability to breach the contracts, although such access limitations could be bypassed either through the analogue hole or through DRM system circumventions. Examples of such *ex-ante* based DRM systems are FairPlay DRM [44] which supports the iTunes online music store, Windows Media DRM [45] which supports, amongst other services, the Napster online music store, and Helix DRM [46] which supports the Real Music Store and the Rapsody online music store.

Ex-post based DRM systems employ monitoring and tracking mechanisms that enable *ex-post* decision making by court. One example is the DRM scheme supporting the eMusic online

store [23] which employs an acoustic fingerprinting technology that reads users' files, and once a match with an eMusic song is made, eMusic sends a DMCA infringement notice to the user with a 24 hour grace period.

While *ex-post* DRM systems are more likely to support Fair Use [16], currently the prevalent DRM systems are *ex-ante* based since the mainstream Music Industry generally avoids *ex-post* based DRM systems [47, 25, 48]. However the launch of iTunes Plus in 2007, supported by EMI Music [24, 25], and NBC Universal's plans to provide presumably DRM free downloads without the assistance of iTunes [49], suggest the possibility of a shift in the mainstream Music Industry's preference, from *ex-ante* based to *ex-post* based DRM.

4.2.4.1 Which is better? *Ex-ante* or *ex-post* based DRM?

Each of the two paradigms has its own pros and cons and thus may be applied for different purposes; no explicit comparisons could be found in the literature surveyed. Their advantages and disadvantages are as variable as the requirements of the particular DRM stakeholders considered. For example, since *ex-ante* based DRM systems are less ambiguous and offer greater control to the copyright holders, they are more likely to be appealing to media companies such as Disney and News Corporation which are reported to adopting hard-line attitudes towards DRM, rather than to companies such as Time Warner and NBC Universal which are reported to adopt more liberal attitudes [29].

In a similar way while traditional audio CD distribution through mainstream Media Distributors is the main distribution channel for mainstream Music Producers; to non mainstream Music Producers the online music market presents a unique distribution opportunity. Since *ex-post* based DRM systems are more likely to support Fair Use [16], and therefore are more likely to be accepted by the consumers, non mainstream Music Producers tend to opt for *ex-post* DRM.

4.2.4.1.1 The Pros and Cons of ex-post based DRM systems

The main advantage of *ex-post* based DRM is that it has an inherently better chance at supporting fair uses [16]; this is because the tracking and monitoring mechanisms that it employs enables the detection rather than the prevention of potentially illegal activity. Once such activity is detected, then the matter is taken offline, where the bottom line would become a court ruling.

Ex-post DRM systems tend to employ watermarking and fingerprinting algorithms, which on one hand present the advantage of providing a protection layer against attacks exploiting the analogue hole; and on the other may be complex, not always very effective, and potentially invading into the Consumers' private space [40].

On one hand, Rosenblatt argued that it becomes counterproductive to rely on *ex-post* decision making. He stated that the judgement on whether each and every case infringes would overload the court system, making it necessary to hire lawyers where ordinarily none would be necessary, and generally superimpose a physical-world timeline on a digital paradigm.

On the other hand, von Lohmann countered this line of thought by stating that whether current *ex-ante* DRM as administered by the copyright owners and DRM Technology Providers shall erode Fair Use or result into a bargain for the public is still to be seen. However, "*…a hard-nosed negotiator for the public will ask for concrete empirical evidence to support the promised benefits of DRM technologies, while demanding limiting principles to protect as much of the public's side of the bargain as possible…*" [37].

4.2.4.1.2 The Pros and Cons of ex-ante based DRM systems

An advantage of *ex-ante* based DRM systems, as argued by Rosenblatt, is their potential to enable a multitude of novel business models [29].

A disadvantage, according to Burk D. L. and Cohen J. E., is that *"…any procedure requiring an ex-ante evaluation of fairness would dramatically raise the cost of fair use by essentially transforming the fair use right from a liability rule to a property rule…"* ; and this would disappear spontaneous uses altogether, and endanger the possibility of anonymous use [34]. Another disadvantage of *ex-ante* based DRM systems is their potential to invade into the Consumers' private space [40].

4.2.5 Is there a relationship between Fair Use and Interoperability?

The importance of interoperability lies in the fact that its absence *"…leads to a number of inconveniences for all of users, content providers and terminal manufacturers:*

- *Users may not be able to use all of their content on all of their devices;*
- *Content providers may need to supply their content in several different formats;*

- *Content in older formats may not be usable by newer terminals (and vice versa);*

- *Control of the DRM market can be used to distort the market for multimedia terminals by controlling which terminal manufacturers are given access to DRM technologies…"* [50].

Whether the lack of interoperability between multiple *ex-ante* based DRM systems is a technically breakable barrier is out of the scope of this project, however many argue that interoperability is at least partially achievable through means such as: trust establishment, standardisation and dynamic late-bound network services [50, 13].

If a song protected under one *ex-ante* based DRM regime can only be played on devices compatible with that regime, then the tune is limited to the functionality provided by devices in that regime, therefore any innovation that could be generated thorough the functionality of other devices is prevented in an *ex-ante* manner, unless the DRM regime is circumvented. Such lock-in would be in conflict with the principles behind Fair Use, therefore on one hand if the DMCA protects non interoperable *ex-ante* based DRM regimes from circumvention, it would also be protecting the *ex-ante* limitations on the exercising of the Fair Use rights, and therefore it would be in conflict with WIPO's ideology. On the other hand, the consent to the use of circumventions that bypass any security binding between the digital content and the responsible legal persons would both enable the flourishing of copyright infringement and minimise the Music Industry's possibility to initiate legal procedures against copyright infringers, and this would still be in conflict with WIPO's ideology. This means that in any case the DRM Technology Providers are likely to have to promote interoperability in DRM.

4.2.5.1 The iTunes Case Scenario – Fair Use and DRM Interoperability

Apple's iTunes is the most popular online music store. Until the 2nd of April, 2007 it employed one major business model, where the Music Industry could offer to the Consumers FairPlay DRM protected music content for download and consumption in line with a set of pre specified rules. Under that business model any music downloaded from iTunes was only compatible with Apple's FairPlay, and FairPlay DRM is a closed system integrated only in the company's software and devices. Consequently Apple was often accused of using the lack of interoperability as a business tactic for the maximisation of iPod and iTunes sales [47].

For example such lock-in resulted into a cat-mouse battle between Apple and RealNetworks, where RealNetworks was unlocking FairPlay DRM by means of its Harmony technology to allow its own business model to interoperate with that of Apple, and Apple was locking its FairPlay DRM again to re-secure the iTunes business model (see Figure 4.2.1) [50, 47].

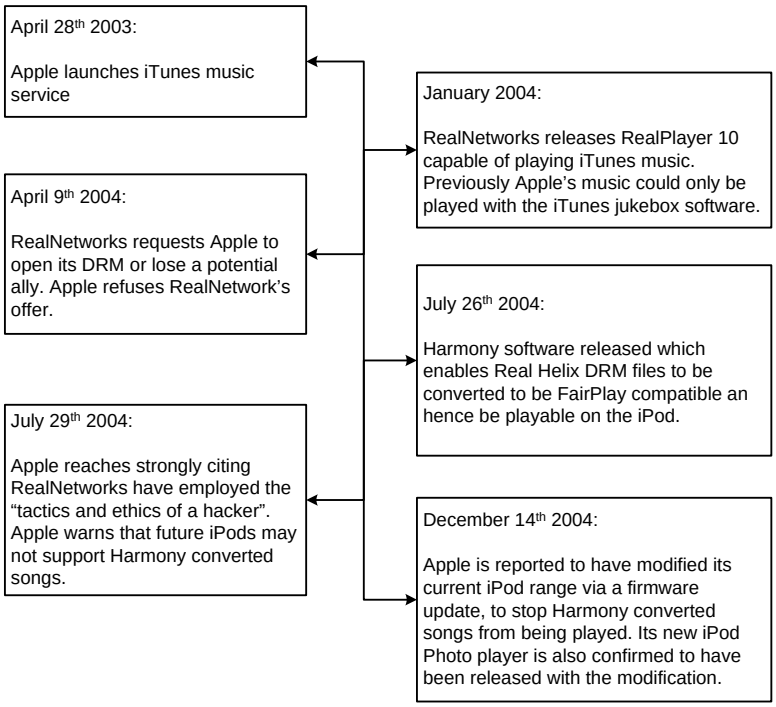

Figure 4.1: Analysis/Timeline of Events

Steve Jobs, CEO of Apple, defended the reasons behind such lack of interoperability on the 6th of February, 2007, stating that interoperability would imply divulging of security secrets which would most probably leak and jeopardise the DRM system [51]. On the 6th of February, 2007 Jobs also declared that iTunes would embrace any decisions from the big 4 Music Distributors to sell DRM free digital content, and that it could not be understood why such distribution is perceived as risky by the Music Distributors, since approximately 82% of the music was distributed through the DRM free audio physical channel, and since only 3%, or 2 billion, of the songs played on iPods were DRM protected [51].

On the 2nd of April 2007, Apple announced that EMI Music's entire digital catalogue was going to be available on iTunes Plus completely "DRM free" at higher quality for 20 pence more than the usual price, also providing to the Consumers the facility to upgrade any previously purchased DRM protected EMI songs to the new format at a 20 pence fee per tune [48], and this was a big step forward towards Fair Use. However, does this mean that EMI

Music and iTunes Plus gave up control? If no then tracking and monitoring would be in place, and this would be at the cost of privacy.

4.2.6 Is there a relationship between Fair Use and Privacy?

Cohen J. E. [40] argued that *"…just as spatial privacy guarantees breathing space for behavior, privacy rights in the information generated by intellectual exploration guarantee breathing space for thought…"*, and this sheds light on the links between privacy, DRM and the ideologies of WIPO which are the basis of copyright law and Fair Use. However for unfair usage to be penalized there must be a link between the Consumers' identities and the content usage, and this would likely be possible at the cost of a level of privacy; therefore it becomes important to determine a balance between privacy and security.

4.2.6.1 The iTunes Case Scenario – Fair Use and Privacy

Although there have been accusations that music from iTunes Plus was watermarked and that the watermarks included the Consumers' name and email address, thus raising privacy issues, according to Peter Eckersley, staff technologist at EFF [52]:

"…While there are no watermarks, there are some other interesting fields that are likely to have privacy implications. In particular, there is a 1024 bit variant field labelled sign and a 630 byte variant field labelled chtb. These are unique for every combination of user and track we've seen. Neither of these fields existed in the FairPlay DRMed .m4p tracks that Apple has been selling in the past.

It's best to assume that either the sign or chtb field could be used by Apple to identify the user who purchased a track (that would be true if Apple logs what it writes in these fields, or if sign is, as it seems, a cryptographic signature). It's also safe to assume that they can be used to tell the difference between real and forged names / Apple IDs in tracks..."

This means that strictly speaking, according to the DRM definition of Chapter 2, iTunes Plus is not completely free of DRM, at the reward of a level of control functionality to Apple and at the cost of a level of the legitimate Consumers and Copyright Infringers' privacy.

The binding between the digital content and the sign and chtb fields seems to be weaker than the binding that would be offered by robust digital watermarking algorithms such as those presented in [32]. Therefore the capability to enforce copyright seems to be weak, the Consumers' loss of privacy is low, and the Copyright infringers' legal risks are small.

4.2.7 Is DRM Circumvention for the purpose of interoperability legal?

The DRM anti circumvention laws that were enacted in the DMCA in conformance to the 1996 WCT, according to EFF reach *"…too far, chilling a wide variety of legitimate activities in ways Congress did not intend…"*, thus *"…hindering the legitimate activities of innovators, researchers, the press, and the public at large…"* [53]. On the other hand if DRM circumvention is allowed, then the existence of DRM could become pointless. However, logically speaking, DRM schemes supporting Fair Use would never need to be circumvented, therefore any Consumers circumventing fair and interoperable DRM systems would likely to be at fault.

4.2.7.1 The iTunes Case Scenario – Fair Use and the DMCA Anti Circumvention Rules

In the case *Lexmark v. Static Control Components (SCC) of 2004* the judge MERRIT. J noted firmly "*…We should make clear that in the future companies like Lexmark cannot use the DMCA in conjunction with copyright law to create monopolies of manufactured goods for themselves just by tweaking the facts of this case…"*. Based on the details of this case, Chandak N. and George C. presumed that should the Apple–RealNetworks cat-mouse battle (see Figure 4.1) have ended in court then the ruling would possibly have supported RealNetworks, as it would perhaps not have promoted the use of the DMCA anti circumvention rules to promote monopolies through the lack of interoperability [47].

If this presumption is correct, given the idea that DRM interoperability conforms to the Fair Use principles; then such ruling would also have been a step forward towards Fair Use through legal DRM circumvention that achieves interoperability. Also, using reasoning similar to the same presumption, it may be assumed that such ruling might also shed light on future court decision making regarding DRM circumventions that achieve Fair Use. However, as explored earlier, should the circumvention of DRM for the purposes of Fair Use and/or interoperability be deemed illegal, then the Fair Use doctrine would be jeopardised in the sense that the Music Industry would be able to bypass copyright law by means of simple contracts, creating its own "copyright" regime; and this would strengthen the adoption of the novel *a priori* based business models suggested by Bill Rosenblatt [29]. Clearly legal rulings about these issues present legal risks to all interested stakeholders; and maybe this why this issue has not yet been taken to court.

On the 2nd of February 2008 Jon Lech Johansen has launched doubleTwist, a venture that similarly to RealNetworks' Harmony technology reverse engineers Apple's FairPlay DRM [54]. It does so by dumping the output of QuickTime streams to files. Section 8.3 of doubleTwist's Terms and Conditions warns the user that s/he should: *"…agree to not engage in the use, copying, or distribution of any copyrighted Communications Content beyond allowable fair use including any use, copying, or distribution of Communications Content obtained through the doubleTwist Services for any commercial purposes…"*.

While the company believes that its services are legal, lawyers believe that Apple will seek to shut it down since *"…the law now specifically targeted technologies which attempted to circumvent measures such as DRM…"*. If this happens, then the extent to which the DMCA anti circumvention laws support the lack of interoperability shall be established; however, given that iTunes may be boarding a "DRM free" or *ex-post* based business model, with the support of EMI Music and perhaps other Music Distributors, this may actually never have to happen.

4.3 Conclusion

With reference to the questions posed in Table 4.1, based on a literature review and discussion, this chapter identifies the following realistic Fair Use properties for a Fair Use friendly DRM Scheme:

- D1: Fair/unfair decision making is ambiguous and therefore the automation of such decision making is AI hard.
- D2: The ambiguity of Fair Use is at the core of the doctrine's strength; therefore DRM schemes aiming to be loyal to current copyright law must find ways to handle the ambiguity of Fair Use.
- D3: The fact that current state-of-the-art DRM is essentially *ex-ante* based does imply a deviation from the Fair Use exceptions and the prevention of spontaneous use; primarily because of the fact stated in D1. In congruence with [16], DRM schemes aiming to be loyal to current copyright law should facilitate *ex-post* tracking and monitoring rather than *ex-ante* based decision making. Said this, it has been established in Section 4.2.3 that major DRM Technology Providers aiming to support mainstream Music Industry driven business models are not in a position to try harder than required by the Music

Industry to support the Fair Use doctrine since their success is dependent on the mainstream Music Industry's participation.

- D4: Interoperability has an impact on the extent to which the Consumers can exploit Fair Use rights.

- D5: Like interoperability, privacy encourages fair usage of digital content, for the reasons specified in Section 4.2.5; however *ex-ante* based and *ex-post* based DRM implies a level of privacy infringement.

- D6: DRM circumvention is illegal; however whether circumvention remains so when it occurs for interoperability or Fair Use is currently unknown; future court rulings shall shed light on the issue. This implies that the design of any DRM scheme should consider its legal position.

D1 – D6 represent the six realistic Fair Use properties for a Fair Use friendly DRM Scheme along with the five idealistic characteristics C1 – C5 of Chapter 3 to propose a DRM scheme which reduces the gap between copyright rights and Fair Use exceptions.

Chapter 5: A Fair Use Friendly DRM Scheme

In this chapter, by considering the set of idealistic DRM characteristics C1 – C5 that were established in Chapter 3 and the six realistic Fair Use properties D1 – D6 that were established in Chapter 4, Section 5.1 determines a set of DRM scheme design decisions which reflect the functionality proposed in Chapter 3 within the restrictions proposed in Chapter 4. Section 5.2 outlines how the decisions of Section 5.1 can be implemented in a real world DRM system. Therefore, the Fair Use friendly DRM Scheme proposed in this project is jointly represented by Sections 5.1 and 5.2. The chapter is the concluded in Section 5.3.

5.1 The DRM Scheme Functionality

As can be seen in Table 5.1 below, a closer look at the characteristics C1 – C5 and the realistic properties D1 – D6 reveals a set of common Fair Use related DRM scheme foundations. Sections 5.1.1 – 5.1.5 discuss these foundations and propose one way to materialise the foundations into a set of DRM scheme decisions.

DRM Scheme Foundations	Chapter 3	Chapter 4
Interoperability	C2	D4
Ex-post fair usage decision making	C1, C2	D1, D2, D3
Privacy	C3	D5
Circumvention protection	N/A	D6
Mimicking of the pre-MP3 world	C4, C5	N/A

Table 5.1: DRM Scheme Foundations

5.1.1 Interoperability

In D4 it is argued that whether a DRM scheme is interoperable or not has an impact on the extent to which the Consumers may exploit the Fair Use exceptions. As explained in Section 4.2.5 the reason behind this is that the lack of interoperability implies limitations on the

number of device functionalities that may be applied on the digital audio content. So for example: if FairPlay DRM protected music can only be played on QuickTime software and iPod devices, then the Consumers do not have the option to export the music to professional sound engineering software and edit it. Consequently any innovation and creativity that could arise from such experimentation will not occur. In C2 interoperability is not discussed into such detail. The characteristic states that the Consumers should be able to consume digital audio content within interoperable regimes.

In this view it is proposed that the DRM scheme supports interoperability. The two related decisions are as follows:

- **Decision 1:** The entity commanding the DRM scheme should be a TTP trusted by all the DRM stakeholders, rather than a commercial DRM vendor with an interest into lack of interoperability as a business tactic.

- **Decision 2:** The security of the DRM scheme should not be substantially relying on obscurity. This enables the publication of standards that enable interested audio device vendors to integrate the DRM scheme components.

5.1.2 *Ex-post* Fair Usage Decision Making

As stated in D1, D2 and D3, since Fair Use is ambiguous and since its ambiguity is the doctrine's strength, then any DRM scheme aiming to support Fair Use should also support its ambiguity. Since the ambiguity is beyond any method that enables *ex-ante* fair/unfair usage decision making, then the support of Fair Use in DRM implies support to *ex-post* based fair/unfair usage decision making. The support of *ex-post* based fair/unfair decision making implies the implementation of mechanisms that enable the tracking and monitoring of digital audio content usage that enable the detection of potentially illegal activities after they happen, in ways that enable judges to take *ex-post* decisions. It can logically be deduced that the requirement of *ex-post* decision making implies the lack of *ex-ante* based decision making, since the latter would not allow occurrence of the former.

It is further argued in D3 that *ex-ante* based DRM prevents spontaneous use. This is because currently the most common form of *ex-ante* based DRM employs contracts which restrict in a fine grained manner the way that the Consumers may consume the content that they have legally "purchased". To give an example, if the contract states that the digital content may be

played on only 5 devices, then spontaneity is prevented in the sense that a user having 6 devices would have to drop one of the devices. In addition the user would not be able to share his content with a friend since the number of permitted devices would be already consumed. While it may be possible to disconnect one device to connect another, this would imply a reduction in usability, which also reduces spontaneity.

It is argued in C1 that the copyright holders should not be allowed to interfere with usage which a judge would or could rule as fair. This essentially means that the copyright holders should not be able to specify *ex-ante* based rules; nor should they be able to revoke the rights that users already posses, unless this is ordered by the Legal Authorities.

On the same lines it is argued in C2 that the Consumers should be able to use the digital content in a spontaneous manner. According to C2 such spontaneity includes the capability to replicate, distribute and store digital content, which shall be discussed in section 5.1.5.

In this view it is proposed that the DRM scheme supports *ex-post* based decision making. The five related decisions are as follows:

- **Decision 3:** In congruence with Decision 1 of Section 5.1.1, the DRM scheme will be managed by a TTP and not by any of the DRM stakeholders mentioned in Section 2.2. Should the scheme be managed, for instance, by the Music Industry, or by a stakeholder influenced by the industry, then the industry would be able to infringe in the way Consumers use their content.

- **Decision 4:** The DRM scheme will enable *ex-post* based decision making and not *ex-ante* based decision making. Therefore the scheme will not make use of rights expression paradigms that specify in unambiguous ways terms and conditions that specify how Consumers should use the digital content. The DRM scheme will enable the tracking and monitoring of digital content usage by embedding watermarks into digital content, and by requiring the devices to log usage transactions and send them to the TTP, so that the TTP will be able to compile and send statistical information to the Music Industry. The Music Industry will then be able to spot illegal usage, and to take legal actions against the presumed copyright breaching people or entities.

- **Decision 5:** The DRM scheme will enable the revocation of DRM system components. This serves many purposes, including the capability to cancel the validity of compromised, lost or stolen components. However revocation due to copyright infringement should be authorised by the Legal Authorities.

- **Decision 6:** Spontaneity will be endorsed by enabling easy access to music on all devices, as long as a valid portable Tamper Resistant Module (TRM) and the DRM protected digital content are available to the person aiming to consume the digital content.

  For example, for an encrypted tune to be played by Bob on Alice's car audio device, all which is required is that Bob inserts the TRM containing the digital audio file decrypting key and the storage device containing the encrypted and watermarked tune into the device; as long as the device is interoperable with the DRM scheme. Bob might also be able to give the TRM and the protected audio content to Alice who wishes to listen to the songs over the weekend.

  There is however one restriction: since both the TRMs and the DRM interoperable devices will need to be updated every D days and the updating requires Bob's authentication, then Alice cannot retain the TRM for longer than the expiry date (see Section 5.2.2).

- **Decision 7:** Spontaneity should be endorsed by enabling the replication, distribution and storage of music in the ways that shall be discussed in Section 5.1.5.

5.1.3 Privacy

Both C3 and D5 recognise that privacy is important. D5 argues that privacy endorses Fair Use. However both C3 and D5 recognise that a level of privacy must be given up in order for the DRM scheme to be able to control the way digital content is consumed. As argued in [2] laws may need to be altered.

In this view it is proposed that the DRM scheme should support privacy. The two related decisions are as follows:

- **Decision 8:** In congruence with Decisions 1 and 3 the DRM scheme will be managed by a TTP which is trusted by everyone. This enables the centralised secure storage of private information.

- **Decision 9:** The DRM scheme will use UIDs rather than personally identifying information to identify content and devices. This is done to reduce the probability of information disclosure upon any DRM security breaches. For example, the digital watermarks will contain UIDs rather than private information about the users to whom they enable tracking to.

5.1.4 Circumvention Protection

As argued in D6 and in Section 4.2.7, should circumvention occur in the name of interoperability and/or Fair Use, the persons conducting such activity might not be found guilty by a court ruling.

In this view it is proposed that the DRM scheme supports protection against legal circumvention. The two related decisions are as follows:

- **Decision 10:** The DRM scheme will watermark the digital content to enable the tracking and monitoring of potentially illegal usage.
- **Decision 11:** The DRM scheme will enable the endorsement of interoperability and Fair Use.

The reason behind these decisions is that by so doing, the Consumers should be less motivated to circumvent the DRM scheme, and if they do bypass the encryption, then they will still need to remove the digital watermark since the digital watermark, as stated in [32] can be resistant to digital-to-analogue-to-digital breaches. If the Consumer manages to tamper with the watermark and such activity is detected by the monitoring and tracking activities, then it is believed that the legal defence for the Consumer would be riskier.

5.1.5 Mimicking of the pre-MP3 world

As stated in Chapter 3, this project takes an approach where the mimicking of the pre-MP3 world's media operation characteristics into a post-MP3 world DRM scheme enables the satisfaction of all copyright stakeholders, since generally speaking this was the case in the pre-MP3 world. It is stated in C4 and C5 that the Consumers should be able to purchase, replicate and distribute music at a monetary cost. The Consumers should also be able to replicate, distribute and store music at the cost of diminished quality, slow replication and slow distribution.

In this view it is proposed that the DRM scheme supports the mimicking of the pre-MP3 world's media operation characteristics. The three related decisions are as follows:

- **Decision 12:** Replication: The replication of music occurs when a Consumer A replicates a digital tune through the TTP at a cost such that another Consumer B can

listen to the tune while using a B's own TRM. The replication implies a level of quality loss which is artificially induced by the TTP (see Section 5.2.5).

- **Decision 13:** Distribution: The distribution of music can occur in one of two ways:
    - Consumer A gives his TRM to person B who may or may not be registered to the DRM scheme; however requiring the TRM to be returned to A since updating will require Consumer A's authentication (see Section 5.2.2).
    - Consumer A transfers the rights to listen to the tune from his TRM to one of Consumer B's TRMs, through the TTP, at a cost.
- **Decision 14:** Storage: Since the TTP stores all transactional information and all encrypting and decrypting keys; should the Consumer lose all his data and all his decrypting keys then the TTP could send all data to the Consumer again, at a cost. The advantage of this over the pre-MP3 world is that the Consumer does not need to cater for backups, and fees are paid only if and when the data is lost.

Section 5.2 aims to briefly show how the functionality described in Section 5.1, can be implemented in a real DRM system. Please note that the actual implementation of the DRM scheme would require extensive design issue and policy considerations, and I point this as an interesting area for future research.

5.2 A Fair Use Friendly DRM Scheme

As can be seen in Figure 5.1, the key DRM scheme components are the TTP, the Legal Authorities, the Consumers, the Tamper Resistant Modules (TRM), the TRM enabled devices, the Music Distributors, and the Music Producers. The Music Producers and Distributors are also seen collectively as the Music Industry. Groups of TRMs mapped to a single Consumer are collectively referred to as TRM groups. Consumers, devices and TRM groups are collectively referred to as a Consumption Domain.

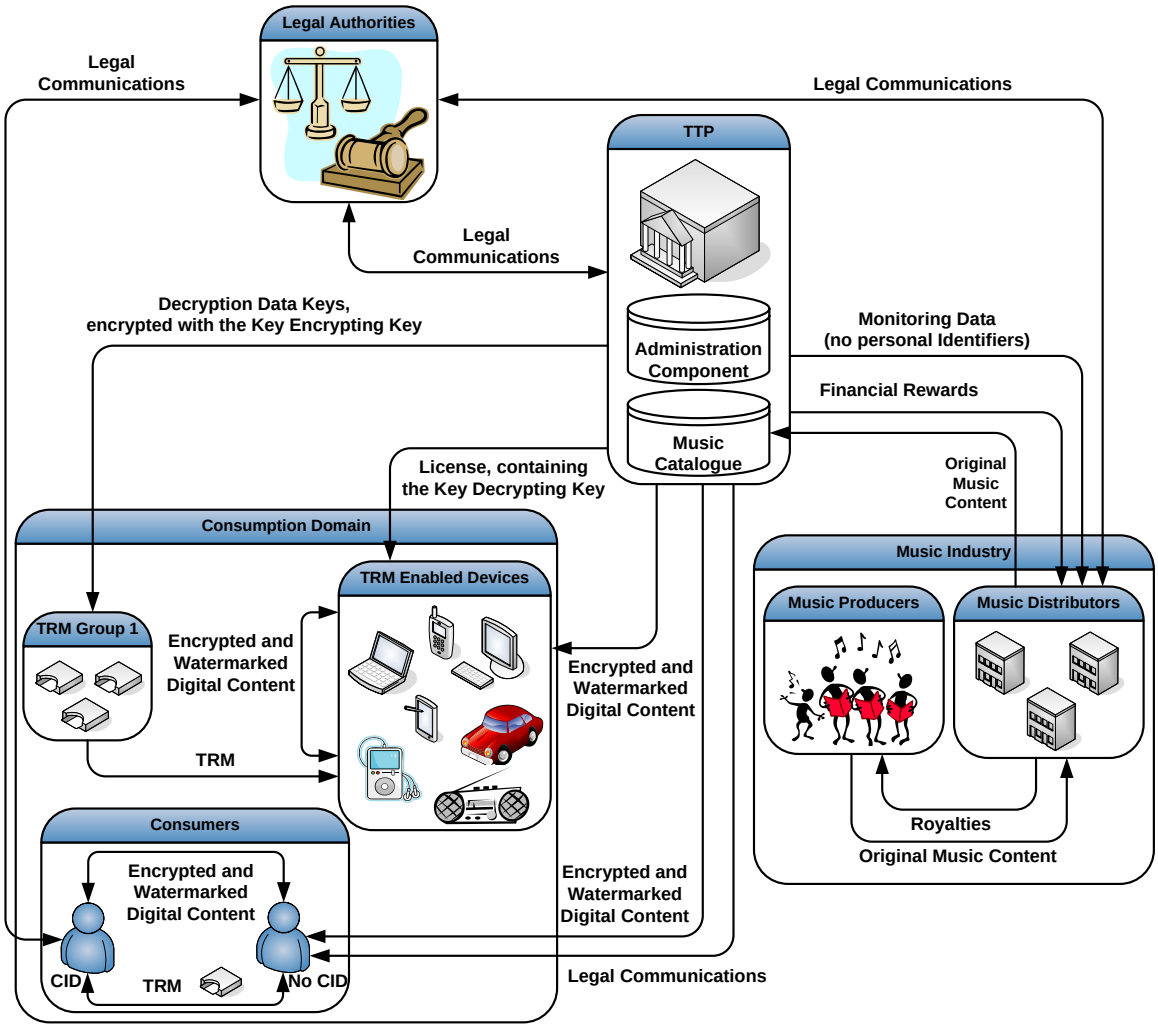

Figure 5.1: The DRM Scheme Overview

5.2.1 UIDs and their Relations to other Unique Identifiers

The use of UIDs is the basis of most *ex-ante* and *ex-post* based DRM schemes. Without their use it would be impossible to track and securely manage digital content; however the unique identification of entities, people, objects and digital content often implies a certain level of privacy infringement; this is as expected (see Section 5.1.3).

The presentation of the Fair Use friendly DRM scheme functionality presented in this Section requires the introduction of the following UIDs: the Consumer Identifier (CID); the Tune Identifier (TID), where any two identical tunes mapped to two different CIDs must have two different TIDs; the TRM Identifier (TRMID); the Device Identifier (DID); the Device License Identifier (DLID); and the Tracking Component Identifier (TCID).

As pictorially represented in Figure 5.2:

- A CID may be mapped to zero, one or many TRMIDs. This implies that every Consumer may own zero, one, or more TRMs. For privacy reasons, records linking the CIDs to TRMIDs are securely stored into the TTP's Administration Component.

- A TRMID can be mapped to no more than one CID; however as explained in Decision 13 of Section 5.1.5, the Consumer may opt to give the TRM to anyone, including people who are not registered to the DRM scheme, if the Consumer would still accept legal liability.

- A TID can be mapped to zero or one TRMID at any given time. This implies that the permission to consume any given encrypted tune may be stored into at most one TRM at any given time. For privacy reasons, records linking the TIDs to TRMIDs are securely stored into the TTP's Administration Component.

- A CID is directly mapped to zero or more TIDs. Each mapping occurs by means of a watermark which contains the CID and the particular TID. The watermark's security properties are briefly specified in Section 3.3.3.6. This is why digital music consumption can be tracked back to the responsible person. For privacy reasons, records linking the CIDs to TIDs are securely stored into the TTP's Administration Component.

- If a TID is mapped to a TRMID, then it has to and may only be mapped to the CID that is mapped to the same TRMID. This means that a tune cannot be encrypted if it is not also watermarked. If it is encrypted in a way to be connected to a Consumer, then the watermark must link the tune to the same Consumer.

- A TRMID can be mapped to zero or many TIDs. This means that one TRM may store keys to grant access to more than one TID; thus essentially TRMs mimic the media used in the pre-MP3 world. For privacy reasons, records linking the TRMIDs to TIDs are securely stored into the TTP's Administration Component.

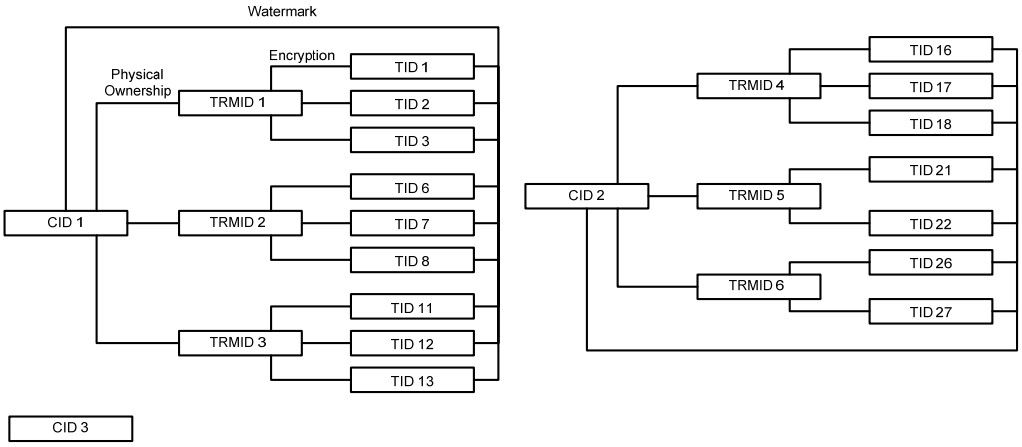

Figure 5.2: Relating CIDs, TRMIDs and TIDs

As pictorially represented in Figure 5.3:

- A DLID can be connected to zero or one DID, by being physically stored into a secure device component. For privacy reasons, records linking DLIDs to DIDs are securely stored into the TTP's Administration Component.

- A DID can be mapped to zero or one DLID. If it is not connected to a DLID or if the DLID is expired, then it will not have access to any encrypted tunes.

- Each device with UID DID must embed at least one TCID. For security reasons, records linking the DIDs to TCIDs are securely stored into the TTP's Administration Component.

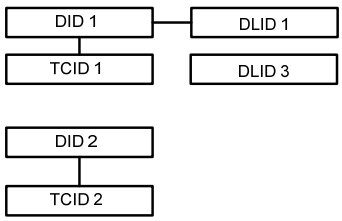

Figure 5.3: Relating DIDs, DLIDs and TCIDs

5.2.2 The TRM Component Updates

The TRM securely stores a list of decryption data keys that enable the decryption and consumption of the list of encrypted tunes mapped to the TRM. All of the data keys are encrypted with a key encrypting key. The key encrypting key must be updated once every D days as follows:

- The Consumer and the TTP are mutually authenticated.
- The TTP encrypts the list of data keys with a new key encrypting key and securely sends the information to the TRM.

The reason underlying this procedure is to enable the revocation of TRMs, for example in the case of lost or stolen TRMs, or in the case of *ex-pos*t court rulings supporting such revocations; however in congruence to Decision 5 of Section 5.1.2, copyright infringement related revocations may not occur unless authorised by the Legal Authorities.

TRM cloning would jeopardise the entire DRM scheme. To prevent this, the TRM is tamper resistant. Since the Consumers' authentication is required for the TRM updates, after D days the cloned TRM would no longer be valid unless the attacker can authenticate using the Consumer's authentication information.

5.2.3 The DLID Updates

The devices' licenses contain the key decrypting key corresponding to the key used to encrypt the data keys stored in the TRMs. Therefore the device licenses must be updated every D days together with the TRMs. The updating occurs as follows:

- The device's owner and the TTP are mutually authenticated.
- The device securely transmits the TCID information to the TTP.
- The TTP securely transmits the new key decrypting key, by sending a new device license to the Device.

This means that after D days the device would no longer be valid for the playing of DRM protected digital content, unless the Consumer's authentication occurs.

The internal device component storing the device license is tamper resistant to prevent license leakages, since the leakage of a license could jeopardise the entire DRM scheme for at least D

days. The determination of approaches to minimise the potential impact of this possible occurrence would be required.

Unless the TCID information is transmitted to the TTP, the new decrypting key is not transmitted to the Device. This ensures that the tracking and monitoring logging information is securely sent to the TTP.

5.2.4 The Tunes Consumption

An encrypted and watermarked tune with TID “R” may be consumed on a device with DID “X” only if the following three conditions are true:

1 A valid TRM granting access to R is physically inserted into the TRM reader of the device with unique identifier “X”.

2 X holds a valid device license with DLID “Y”.

3 The device has “physical” access to the encrypted and watermarked tune with unique identifier R.

As shown in Figure 5.2 every tune is linked to one TRM which is in turn linked to the legal owner with CID M. The cryptographic binding between the tune and the TRM is a result of the encryption of the tune using a data encryption key whose corresponding decryption key is securely stored in the TRM. Therefore if a user inserts the TRM into a device for consumption; then the DRM scheme knows that the tune is consumed by someone holding a legal TRM, and M is responsible for that TRM.

A tune is also cryptographically bound directly to the legal owner M by means of a digital watermark which is incorporated into the tune; the digital watermark includes both the CID of and the TID of R. Therefore if the digital tune is used outside the boundaries of the DRM scheme, the use may be tracked using the employed tracking and monitoring mechanisms. Such activity would then need to be assessed by a judge to decide on whether it is fair or not.

5.2.5 Replication of Digital Music Content

As stated in Section 5.1.5 the replication of music occurs when one Consumer replicates a digital tune through the TTP at a cost such that another Consumer can listen to the tune while using a second TRM. The replication implies a level of quality loss which is artificially induced by the TTP. As can be seen in Figure 5.4 below, the replications of the original content A resulted into second replications, and each of these could be replicated again to result into third replications. The process can actually be infinite, and this mimics the replication of MCs that occurred in the pre-MP3 world. The DRM scheme could decide on policies such as for example: the owner of an N^{th} replica can purchase the original content at the original price minus the price paid to generate the replica.

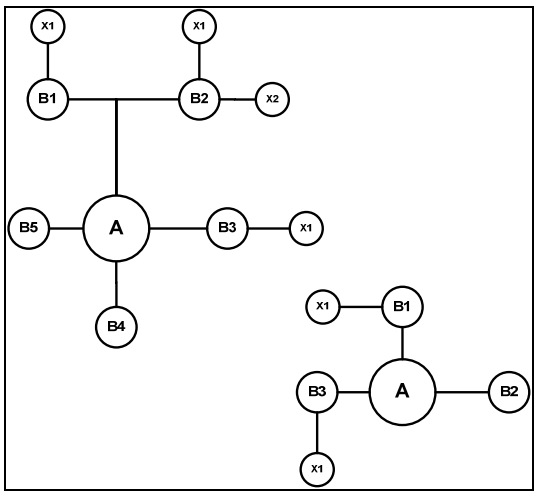

Figure 5.4: Rooted Replication Trees

5.2.6 Distribution of Digital Music Content

As stated in Section 5.1.5 the distribution of music can occur in one of two ways:

- A Consumer gives his TRM to any other person who may or may not be registered to the DRM scheme; however rendering the TRM unusable as soon as D days pass, since updating will require the TRM owner's authentication. This type of distribution mimics the pre MP3 world in many ways, however in this case it occurs at the TRM owner's legal risk, since any illegal usage of the TRM tracks the activity to the TRM owner.

- A Consumer transfers the rights to listen to the tune from his TRM to a TRM owned by a second Consumer, at a cost.

5.2.7 Storage of Digital Music Content

The DRM scheme stores all digital music content into the Music Catalogue and all transactional information into Administration Component (see Figure 5.1). The two components enable the regeneration of any of the songs that had been distributed in the past. Therefore the DRM scheme is in a position to offer a “backup” service where digital content is stored at the TTP, along with the decrypting data keys and if any data is lost the Consumers can restore all the content for a fee.

5.3 Conclusion

The scheme presented in this chapter constitutes a novel approach towards the reduction of the gap between copyright rights and Fair Use exceptions in DRM. As shown in the introduction of Chapter 3 this is not the only possible path forward towards the bridging of the gap between copyright rights and Fair Use exceptions in DRM. Whether the scheme would be successful in a realistic environment or not is highly dependent on the quality of the digital music content that it attracts. In an epoch where prevalent online music stores such as iTunes seem to be moving from *ex-ante* based DRM systems to DRM free business models; and where the general public seems to become less sensitive about privacy, given the proliferation of social networks such as Facebook, Hi 5 and Bebo; it is reasonable to state that the DRM scheme presented in this chapter is likely to truly be an approach acceptable to all. The key weakness of the approach adopted in this DRM scheme, which may be looked at as the price to pay, is the dependence of the DRM scheme on tracking and monitoring mechanisms. This was unavoidable if copyright law was to be conformed to. The use of fingerprinting along with or as a substitute for digital watermarking has not been explored; neither has the DRM scheme explored the application of the concepts for the protection of broadcasted digital content.

Chapter 6: Conclusion

The main aim of this project was to reduce the gap between Fair Use exceptions and Copyright rights in DRM. It has been established that one approach towards reaching this objective is to integrate as much as possible of the following set of idealistic characteristics:

- The copyright holders should not be able to interfere with usage which a judge would or could rule as fair use.
- The Consumers would be able to consume the content easily and spontaneously within interoperable regimes.
- The Consumers' privacy rights would be respected, in congruence with the legislation in question.
- The Consumers should be able to purchase, replicate and distribute music at a monetary cost.
- The Consumers should be able to replicate, distribute and store music at the cost of diminished quality, slow replication and slow distribution.

However, these characteristics alone were not suitable enough since they do not specify how and within which legal restrictions the characteristics should be implemented within a DRM scheme. Therefore Chapter 4 presents the results of a literature review which also specify the following realistic Fair Use friendly DRM scheme properties:

- DRM schemes aiming to be loyal to current copyright law must find ways to handle the ambiguity of Fair Use; and therefore not attempting to make fair/unfair use decisions.

- The fact that current state-of-the-art DRM is essentially *ex-ante* based does imply a deviation from the Fair Use exceptions and the prevention of spontaneous use; and therefore *ex-post* based DRM should be opted for.

- Interoperability has an impact on the extent to which the Consumers can exploit Fair Use rights.

- Privacy encourages fair usage of digital content, for the reasons specified in Section.

- The design of any DRM scheme should consider its legal position in terms of anti circumvention law and the possibilities they give to the Consumers.

The two sets of requirements could then be integrated to develop a DRM scheme which is: flexible in the sense that it does not technically restrict the use of content in an *ex-ante* manner; reasonable in the sense that it provides to the Consumers the required infrastructure to be able to use digital audio files in the same way that traditional CDs and MCs could be used; and persistent in the sense that it enables the tracking and monitoring of digital content usage in a way that allows the copyright holders to take legal action against presumed copyright infringement in conformance to Copyright law. In addition the DRM scheme empowers a TTP rather than the Media Industry; and this is done to ensure that the DRM scheme is implemented in accordance to the law, since as identified in Chapter 4 this is currently not always the case.

The future of *ex-post* based DRM seems to be particularly interesting. Firstly as seen in Chapter 4, future legal decisions about DRM circumvention in the name of Fair Use or interoperability might or might not render the utility of *ex-ante* based DRM almost completely useless for copyright protection. Secondly, also as shown in Chapter 4, the Music Distributors and online music stores seem to be shifting from *ex-ante* based DRM towards *ex-post* based DRM. Thirdly, the security of *ex-post* based DRM relies on Digital Watermarking, Digital Fingerprinting, and tracking and monitoring mechanisms, amongst other technologies; therefore future research on the integration of such mechanisms into DRM is required; fourthly, as has been discussed, one of the main issues which is currently greatly unhandled is privacy, and perhaps this is an interesting area for both computing and legal research.

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