

# Evaluation Criteria for Digital Rights Management Schemes with Focus on Music E-business

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**Abstract:** The networked environment we live in is changing our consumption habits. Peer-to-peer distribution networks, enabled by high-speed home connections to the Internet, have raised fear in both the music and the movie industry. In the past few years, however, this attitude has changed. Instead of condemning peer-to-peer applications, the industry has made an honest effort to turn them into profit. Securing revenue will, however, require some form of technical protection. This is where Digital Rights Management (DRM) steps into the picture. In this paper we developed a set of common criteria that can be used to evaluate both open and proprietary DRM schemes that are intended for protecting digital music. Our criteria take into account issues that are important for both the content provider as well as the end-user. We evaluated four DRM schemes against the criteria: Apple's Fairplay, RealNetworks' Helix DRM, Microsoft's Windows Media DRM and OMA DRM 2.0. None of the evaluated schemes fulfil the evaluation criteria completely - yet the criteria do identify the strengths and weaknesses of each scheme well. We conclude that the end-user is likely to benefit from an open and standardised scheme as it will not create vendor or device lock-in. A standardised scheme can also likely be secure because of extensive technical review during the standardisation process. However, the thorough standardisation process might take too long time for the content providers. By making a proprietary scheme, the content provider can cut the time to market in hope of quickly claiming new and emerging market shares. Market shares can also be secured by making rich and attractively priced content available through online shops that are easy to use.

**Keywords:** Digital Rights Management, Music, E-business

## 1. Introduction

Interesting content is something that always has attracted the consumers. As interesting content is likely to generate revenue, the content providers are constantly looking for new and emerging distribution channels to use. The established revenue sharing mechanisms and business models may, however, not be directly applicable to these new media formats. One such format is content distribution in the mobile environment.

The mobile environment has recently become interesting for the content providers because of the technological advancements in both storage capacity and processing power of handheld devices. A matchbox sized multimedia device can store several tens of hours of compressed digital music that the consumer can listen to independent of location and time. The content formats will, however, not be limited to music only. We have already seen handheld devices that have been tailor made for gaming and amusement. Currently ongoing standardisation also indicates that television broadcast intended for handheld devices will be reality within a few years.

One important enabler for all these new distribution channels is a well proven content protection mechanism. It is simply impossible to make a successful business case in an environment where the content provider's content is likely to end up on a peer-to-peer network within few hours after release. The content providers are simply not willing to take the risk of producing and making advanced and rich media content digitally available for the consumer if the underlying business case is even a bit shaky.

Digital Right Management (DRM) is a technology concept intended to protect the interests of the content providers. DRM enforces copyright by allowing the content provider to set the rules for and the restrictions on how the distributed content can be used. The rules can e.g. be set to limit content usage and viewing times while the restrictions can prohibit things like content modification and superdistribution (i.e. content distribution from one device to another) (Luukainen 2004, Sobel 2004).

To date there has been no common and completely open DRM scheme available. Some open schemes have been standardised but they have not provided strong enough protection to be widely adopted. This has partly been the reason why different technology and software manufactures have come up with their own proprietary content protection solutions. These proprietary solutions do, however, differ from each other in the way which they allow the content provider to set restriction policies and limitations. Thus, the different schemes all have their distinct advantages and disadvantages.

In this paper we developed a common set of criteria to evaluate the proprietary DRM solutions from the following manufacturers: Apple, RealNetworks and Microsoft. We also include the following two open DRM solutions in the evaluation: Open Mobile Alliance (OMA) DRM and Coral. The used evaluation criteria takes into account issues like maturity of technology, scheme survivability, subscription control, online shop success, and content policy control. Based on available literature, the DRM schemes are evaluated one by one and the results are presented in a tabular form. Finally conclusions are addressed.

## **2. Digital Rights Management**

Digital Rights Management (DRM) is a technical term that commonly is used to indicate that usage and copying of digital content is somehow controlled (Luukkainen 2004). This control might technically be applied using either content encryption or digital watermarking. In applying these techniques, the content provider is able to secure the distribution of the content, hence protecting content related intellectual property rights and securing revenue (Pitkänen 2002).

Music is a repetitive good and sharing music need not necessarily be wrong. Applying a DRM scheme does not mean that users will no longer be able to share. Studies like (Brown 2001) have in fact shown that one of the most widely used way to share content is sharing that takes place amongst friends and family. By enabling limited and controlled sharing, the content can be sold all over again by allowing individual customers to act as intermediate "sales representatives". DRM might, for example, be used to allow sharing of a song in a "listen once" fashion. If the receiving party finds the song attractive, it is likely to lead to a new purchase. Content providers might in fact encourage such sharing by introducing additional rewards and bonuses for actively sharing customers.

Current DRM schemes have, however, not yet proven to be silver bullets. The DRM technology used by Apple has both been reverse-engineered and later partially hacked. Microsoft's solution has not been completely efficient either. Content protected by Microsoft's DRM is easily found flowing freely on peer-to-peer networks like KaZaA and BitTorrent. The decentralised nature of these infamous peer-to-peer networks makes them difficult to oversee and control (Pitkänen 2002, Rosenblatt 2003). Thus, controlling digital rights in such a network becomes virtually impossible. Looking back, the now discontinued peer-to-peer network, originally known as Napster, might in fact have been a great opportunity for content providers to collaborate with. The centralised nature, not to mention the well-known status that Napster once enjoyed might probably have suited content providers fairly well. E-business for music had, at that time, however, not quite been worked out yet.

## **3. Music Stores and Players**

Napster showed the power a peer-to-peer network could have in a community that was getting increasingly networked. It did not take rather complex calculations to figure out the potential such a world-wide network could have on content distribution. By being able to control even a small percentage of all the ongoing exchanges, the content provider could rely on almost guaranteed revenue. All that was needed was an easily accessible service, sensible priced content and an interface that was both appealing and easy to use. The online music store had been born.

### **3.1 iTunes and iPod**

Apple was the first one to react by opening the iTunes music store in January 2001. iTunes included both evergreens as well as hits topping the charts for a price of 99 cents each. Apple also took into account the customers' local interests. Currently country specific iTunes shops are available in over 20 different countries. With free iTunes jukebox software, the DRM protected songs can be organised and played on the customer's home computer as long as it is running on either Apple's or Microsoft's operating system.

Apple did not stop here. In late 2001, Apple took iTunes one step further by introducing the portable iPod (Apple 2004, Wikipedia 2004) music player. The iPod enforced Apple's DRM, and the customer was able to make his music collection mobile. Going mobile was made even easier by equipping the iPod with a fast transmission link, storage space for up to 10.000 songs, and seamless integration with the previously mentioned jukebox software.

The sensible priced iPod was an immediate success. According to (Wikipedia 2004), iPod has to date been the most popular MP3 player in the U.S. Hence, it is no surprise that the iPod has been one of Apple's most important revenue products. In addition to revenue, every iPod that gets sold is automatically strengthening the position of Apple's DRM technology by locking yet another customer into using the iTunes music store.

### **3.2 RealPlayer Music Store**

RealNetworks' music store has been experiencing good acceptance since its release in July 2004. The music store integrates with the well known RealPlayer software and music purchased from the store can be transferred to and played on over 100 different portable media players. One of RealNetworks' big drawbacks is that only residents of the U.S. are allowed to sign up as customers. By supporting playback on almost all major media players the RealPlayer music store is a serious competitor for Apple's iTunes. Also, by including support for playback on selected versions of Apple's iPod, RealNetworks has entered the fight for such market shares that have been completely closed and exploited by Apple alone.

Support for Apple's iPod is realized through something called Harmony technology. Harmony allows the RealPlayer software to mimic the encryption that is used by iTunes. Apple claims that this course of action is illegal as information about the used encryption has been gathered by a process of reverse-engineering. In addition, Apple has threatened to change the used encryption in order to block the encryption functionality used in the RealPlayer. (Thurrott 2004)

RealNetworks has, however, not been discouraged. By launching the "Freedom of Choice" campaign, RealNetworks claims that users should be able to buy their music from anywhere they want and for any device they want. By promoting interoperability amongst different devices and different DRM schemes, the campaign is trying to encourage consumers (mostly iPod owners) to take action against Apple. In the spirit of the campaign, the RealPlayer music store has also teamed up with RollingStones.com by offering selected hits for 49 cents each from a weekly changing list. (Shaffer 2004)

### **3.3 Windows Media**

Windows Media music store is not a single store but a joint collection of individual online stores reachable through Windows Media Player. The main purpose of the Media Player is to interface the store and to enforce Microsoft's DRM. Microsoft's DRM allows for service like content purchase, subscription, promotion as well as rentals. The used business models, the pricing, and the supplied content are exclusively defined by the store alone. To date, Microsoft is listing over 70 portable devices that can be synchronised with Windows Media Player in order to play songs that have been protected by Microsoft's DRM.

## **4. Evaluation Criteria**

When evaluating the different DRM schemes we have selected such a set of criteria that take into account aspects of both content providers as well as end-users. Content providers are mostly concerned by the security of the technology. Security is an important aspect as it can be used to enforce desired control of the content, at the same time securing any potential revenue. The content providers are also interested in how flexible the technology is. The more flexible the technology, the more control the content provider will have over the content. More control, on the other hand, means a wider variety of supported business models and marketing strategies.

Good flexibility is also favouring the content provider in the sense that a flexible scheme is likely to be adopted by a notable range of device manufacturers, hence widening the potential customer basis. The maturity of the scheme and the repudiation of the group responsible for developing the technology are also important factors. A mature scheme is likely to be easy to deploy and backing from a well known developer group might ensure survivability of the scheme.

As revenue almost solely stems from sold content, the success and the supply of the used online music shop is important for the content provider. A well off music shop with rich content is much more attractive to the customer than a music shop with limited and outdated supply. As all music shops are not alike, it makes an equally important issue for the customer to be able to select which shop to do business with. Some customers might prefer attractive pricing, some might favour shops with music from particular genres while some simply might make their purchase by force of habit. Besides being able to select which music shop to do business with, the end-users are likely to favour similar things as the content providers. The reasoning might, however, not be quite the same.

A flexible technology will allow the end-users to consume the purchased music in several situations by allowing playback on devices like handheld players, car stereos, laptops and desktop computers. Some end-users might also be interested in backing up already purchased content. Efficient sharing of content amongst heterogeneous devices will, however, require some form of easy-to-use content management software.

Efficient management software also becomes important as soon as the amount of purchased content increases above some threshold. End-users would likely appreciate the ability to quickly locate those long forgotten evergreens amongst a collection of several thousands of songs. The located evergreens might, however, not be of much use if scheme survivability is not guaranteed. Thus, it would be important for the end-user to be able to listen to those evergreens, in say 50 years, regardless of how futuristic the playback devices at that time might be. Interoperability with a large range of devices is of importance also in the sense that it will enable the end-user to replace a broken playing device or upgrade it as desired.

We conclude the discussion above by defining the following set of evaluation criteria:

**Maturity of technology** The content provider will likely find it easier to deploy and integrate such technology that is well proven, thoroughly tested and without too many identified security issues. End-user devices with implementations based upon mature technology are also likely to include fewer bugs

**Scheme survivability** The content provider would like to stick to a long lived scheme while the end-user would like to make sure that any purchased content can be consumed well into the future.

**Subscription control** Flexible control will enable content providers to set up policies like pay-per-view, fixed subscription, content preview, etc. The more subscription control that is available, the more business models can be created. Multiple business models, on the other hand, will ensure that all end-users will find a model that suits their wallet well.

**Online shop success** Online shops that can satisfy the majority of the customers' needs are likely to be well off. Success is dependent on things like pricing, quality, and availability of content.

**Content policy control** Loosely defined content policies are likely to be appealing to end-users. Flexible sharing will for instance allow end-users to use purchased content on a wide variety of heterogeneous devices making content consumption independent of location. Content policy control is also of importance to content providers. Inflexible DRM schemes that are enforcing too restrictive policies are not likely to survive in the long run.

All criteria mentioned above will in a way or another affect how widely the DRM scheme gets implemented in end-user devices. Widespread device vendor support is an issue not to be taken lightly. History has, several times, proven that the best technical solution does not always prevail. Thus, it would not be that surprising if a technically weak DRM scheme would be amongst the sole survivors only due to a large range of supporting devices.

## **5. Proprietary Schemes**

### **5.1 Apple Fairplay**

Fairplay is the DRM scheme developed by Apple for encrypting audio files. Hence, every song that is purchased from the iTunes music shop comes encrypted with Fairplay. Once a protected song has been purchased it is automatically subordinated to the user's iTunes jukebox software. Once the jukebox is in control, it will enforce any restrictions set by the Fairplay DRM scheme.

The used encryption keys are stored both in the jukebox's key repository as well as on Apple's servers along with any additional customer information. The benefit of storing the keys on Apple's servers is that the user can authorise additional computers to play the purchased songs. When a computer gets authorised, all keys belonging to the user are automatically fetched from the servers and added to the authorised computer's key repository. Up to five computers can simultaneously be authorised to play the protected songs.

Additionally, Fairplay allows users to share songs in an unrestricted fashion to either iPod devices or to standard music CDs. Copying music to a CD will, however, affect the audio quality. As the used audio encoding is lossy, any purchased song is inherently suffering from some deterioration in audio quality. The quality will deteriorate even more if the music on the CD ever is re-converted back to any compressed file format.

Even though Fairplay, to date, has been the most successful DRM, its protection has proven not to be strong enough. The Fairplay DRM scheme has first been circumvented, then reverse-engineered, and finally partially hacked. Software like PlayFair, HYMN, and PyMusique (Wikipedia 2004) have been released on the Internet promising to remove the encryption from any legally purchased song.

## **5.2 RealNetworks Helix DRM**

Helix DRM is an extension to the RealPlayer software that provides a flexible and comprehensive platform for secure delivery of rights managed content. Helix DRM supports different file formats for audio as well as video. This gives content providers the possibility to reach different devices under the same DRM scheme. In addition, the flexibility of the Helix DRM accommodates a wide range of rights management systems and different business models such as subscription, purchase, rental, pay-per-view, and video on demand (Helix Community 2003, RealNetworks 2004).

Helix DRM is already included in a wide variety of portable devices and Helix DRM also includes the specifications of the OMA's DRM in its releases (Shaffer 2004). By doing so, OMA DRM can easily be enforced in any device supporting Helix DRM. OMA DRM is described in section 6.1.

Helix DRM separates contents from rights. This allows swift changes in business cases without the need to re-encode and re-distribute the content. The scheme support multiple usage rights which can limit content usage either by the number of times a file can be played or by defining a specific window of time when playback is allowed. Likewise, secure content can be distributed via streaming, downloads, physical media, or peer-to-peer networks (RealNetworks 2004).

## **5.3 Windows Media DRM**

The Microsoft Windows Media DRM for Portable Devices (also known as Windows Media DRM) is a lightweight technology that allows portable devices to store and play protected content. Microsoft is licensing this technology for any manufacturer willing to sign the license agreement. The agreement includes several design criteria which must be fulfilled by the manufacturer in order to secure the protected content as well as the Windows Media technology. The license itself comes with a porting kit including functions that can be used to process Windows Media DRM protected content. The functions are provided in ANSI C making the technology available for non-Windows devices as well.

The Windows Media DRM scheme is flexible and allows implementation of such features that are likely to be suited for almost all content providers' business models. The supported content restrictions include: number of times content can be played, validity time of the content, content encryption mechanisms and, content copy restrictions (like copy count). These restrictions are enforced using mechanism like metering, secure clocks, and portable device licenses. Portable device licenses allows for content and content right to be separated. (Microsoft Corporation 2003)

Although Windows Media DRM is supported by literally all MP3 players on the market its main drawback is the lack of focus given to the users. The DRM relies completely on the providers' policies which can result in an unfriendly device environment.

The latest technological innovation from Microsoft is something known as Janus. Janus is included in Windows Media Player 10 and it allows for a so called "all-you-can-eat" subscription model. With such a subscription the user has access to an unlimited amount of songs for a flat monthly subscription fee. The downloaded songs are equipped with a time limit. In order to keep playing the songs, the user must periodically refresh the subscription. If the subscription is terminated an additional fee must be paid for such content the customer wishes to keep. Time will tell how warm a reception Janus enabled portable device will have once they start emerging on the market (Bernoff 2005).

## **6. Open Schemes**

### **6.1 Open Mobile Alliance DRM**

The scope of OMA's DRM is to enable the controlled consumption of digital media. This control is enforced by allowing content providers the ability to manage previews and to enable superdistribution as well as content transfers between DRM agents.

Version 2.0 of the DRM scheme standardised by OMA makes a logical separation between the content and the content rights. OMA's scheme is using a secure package for the encrypted content. Besides containing the protected content, the package can hold additional information such as vendor and purchase URL. Content rights, on the other hand, are defined by the Open Digital Rights Language. The language can be used to describe both permissions (play, display, execute) and constraints (count, date range, time period).

The users can freely distribute any OMA DRM encrypted content on any available network. This is because the only way the content can be consumed is in the presence of valid content rights. The rights are usually encapsulated into something that OMA calls a Rights Object. A Rights Object is cryptographically bound to the user's device in such a way that only the DRM agent of the device is

able to access it. The DRM agents are securely authenticated by using standard PKI (Public Key Infrastructure) procedures. (Open Mobile Alliance 2004)

The Rights Objects can either be delivered combined with or separated from the content. Forward lock is a special case of combined delivered where the user simply is limited from forwarding the content to any other device. In the normal case of combined delivery the DRM enabled package contains both the encrypted content and the rights agreements. The content can, however, be forwarded to another device. Finally, in separate delivery only the encrypted content is delivered. This content is tagged with a reference back to such a service provider that is able to provide the terms and conditions on the usage of the content. The provider might also be able to go through with a purchase process.

OMA DRM is a technology that has been evolving slowly but at a steady pace. The previous version (1.0) of OMA's DRM scheme was already implemented in some portable devices but the restrictive standard did not make the scheme a serious alternative. With the release of version 2.0, OMA scheme provides a complete technology that seems to be gaining increasing acceptance from content providers, manufacturers, and operators.

## **6.2 Coral**

Coral is a new open technology that emerges from the necessity of interoperability among different DRM schemes. Different key players such as users, providers, and developer have diverse needs which have to be solved independently. Coral's approach is to separate the standardization of DRM schemes from the interoperability issue. Coral is set out to create an interoperability layer through which DRM components can interact. This layer is needed because platform specific DRM components are likely to evolve in different directions with different pace. It does not matter whether the DRM scheme is open, closed, or proprietary as long as the manufacturer is ready to allow for interaction with the Coral layer (Coral 2004).

Coral brings together key players from all parts of the content production chain to work on this lightweight interoperability layer framework. Hewlett-Packard, Intertrust, Phillips, Sony, Panasonic, Samsung and Twentieth Century Fox are amongst the founding members. Considering the influence of these players, this technology (still in its initial phase) is likely to gain attention in the near future (Coral 2004, Faultine 2004).

## **7. Proprietary vs. Open Schemes**

Proprietary DRM schemes include solutions that are based on the developers' own research and results. Proprietary technologies are usually available much faster than standardised solutions since they need not be reviewed by and processed in different standardisation bodies. This can be considered both an advantage as well as a disadvantage.

Proprietary schemes are likely to appear on the market before the open schemes. This usually means that they already have secured some market share once a standardised solution eventually gets released. Furthermore users might use a particular technology over another (possibly better) one just because they are accustomed to it, they like it, they want to support a particular company or they simply are locked-in with it.

Getting locked-in with a particular technology is a common feature of proprietary technologies. This means that the user does not have the ability to change the technology used without virtually losing everything that already has been spent on the old technology. This of course is beneficial for the proprietary DRM providers since content protected by their scheme will continue to be purchased as long as the locked-in users do not bother to change.

Thus, the benefits of an open standard are clear. An open standard does not lock the user into a particular vendor or content provider in the same manner as a proprietary scheme does. The goal of an open standard is to maximise the choices the end-user has by creating a fair and competitive market. If an open standard is found to be reliable, robust, and easy to implement then it is likely to gain support from the device manufacturers. Once devices supporting the standard start emerging on the market, the content providers are likely to get interested.

Some companies are in fact already loosing up on their proprietary scheme. RealNetworks already allow different DRM schemes to interoperate with their own scheme. Microsoft, on the other hand, is licensing the Windows Media DRM to any one willing to sign the license agreement.

Table 1 presents the results of our technology evaluation. The used set of criteria (as presented in section 4) is listed on the left while the evaluated technologies are represented as columns.

Table 1: DRM evaluation

Criterion	Microsoft DRM	Fairplay DRM	Helix DRM	OMA DRM 2.0
Scheme	proprietary	proprietary	proprietary	open
Maturity of technology	good	fair	good	good
Scheme survivability	good	very good	good	very good
Subscription control	very good	limited	good	very good
Online shop success	poor	excellent	good	-
Content policy control	good	very good	good	good

## 8. Conclusions

The iTunes music shop sales are huge and iPods sales have increased substantially since 2001. The success of Fairplay, Apple's DRM is, however, completely bound to the popularity of the iPod. The big drawback with Fairplay is its lack of interoperability among any other devices than iPods. The iPod is designed only to play such music that is protected with Fairplay. The community is, however, fighting back and Apple's uncooperative strategy could lead Fairplay to its own downfall.

In comparison to Fairplay, Helix DRM and Windows Media DRM are quite flexible schemes. These two schemes give the content provider much freedom in defining rules and policies for the offered content. The secrecy behind the technology used makes these two schemes fall into the proprietary class. The developing companies do, however, allow for these two schemes to be licensed, promoting (at least in principle) device interoperability.

Since its release in 2004, version 2.0 of OMA's DRM scheme has gained wide acceptance. Manufacturers like Nokia have promised to include a DRM agent implementing OMA's scheme in all their upcoming multimedia models (Nokia 2005). Nokia is not a manufacturer of pure portable music players but the share volume Nokia's products has on the consumer market can very well prove to be decisive in the future. OMA's standard has also received its blessing from RealNetworks.

There has been some speculation that Nokia's firm support for OMA in fact is an attempt to keep Microsoft from entering the mobile market. These speculations do, however, not quite hold water. According to (Microsoft Corporation 2005) Nokia has recently teamed up with Microsoft in an attempt to make Windows Media DRM and OMA DRM interoperate. This means that Windows Media Player will be equipped with support for OMA DRM while Nokia will implement additional support for Windows Media DRM in some of the upcoming models.

As the mobile phone manufacturers start to enter the picture, year 2005 promises to be tumultuous on the mobile DRM scene. We can only hope that the end-users' desires are not completely forgotten in the tumult.

## 9. Acknowledgements

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