AN EXPLORATION OF RIGHTS MANAGEMENT TECHNOLOGIES USED IN THE MUSIC INDUSTRY

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I. INTRODUCTION

In April 2006, a Judicial Panel on Multidistrict Litigation consolidated claims from three separate districts in a lawsuit against Sony BMG Music Entertainment for a piece of software that the corporation included on four million CDs sold in retail outlets. [1] The software, eXtended Copy Protection (XCP2), buried what is often called a "rootkit" in low level areas of the end user's personal computer, presumably without notice by the end users. [2] This software attempts to monitor and control the consumers' use of the CD, preventing them from illegally copying the CD and disseminating its contents on the internet. The result, as alleged in the lawsuits, was higher susceptibility to computer viruses and other damage. [3] Sony BMG eventually recalled millions of copies of fifty-two albums that contained XCP2 software from record store shelves amidst a storm of media activity around the issue. [4] Sony BMG's use of XCP2 software, made by British firm First 4 Internet, first came to public attention on October 31, 2005 when a blogger posted detailed information about the software on his website including a warning for people to avoid Sony BMG CDs for the time being. [5] On November 10, 2005, the first virus exploiting XCP2 software was announced. [6] On November 16, 2005, United States Computer Emergency Readiness Team [hereinafter US-CERT], a division of the Department of Homeland Security, issued an advisory on the XCP2 Digital Rights Management System, including a warning about putting affected discs in computers. [7]

On November 19, 2005, the Attorney General of the State of Texas filed a lawsuit against Sony BMG. [8] This action was followed promptly by class action lawsuits in California and New York. [9] Nine actions from New York, one from California, and one from New Mexico were involved in the consolidation action of April 2006. [10] Elsewhere, a complaint to the Federal Government was filed in Italy against Sony BMG. [11]

With this flurry of lawsuits, the term, "Digital Rights Management" was thrust into the court system. As the consolidated action settles and the term "Digital Rights Management" makes its way into common parlance as well as legal nomenclature, an opportunity arises to discuss the history of rights management systems in the audio industry that has led to the current situation.

This comment will analyze the complex history of rights management in the music industry over the past 100 years. This history includes a technical look at the difficulties in enforcing copy controls, various music release formats and the rights management systems on which those formats relied, and the struggle with adding ex post facto rights management systems to formats that are already pervasive. This comment then discusses the various reasons why rights management systems are not only desirable, but necessary in today's environment. With a thorough background of the issues relating to rights management, recommendations are provided as to how to remedy the various problems that plague the music industry and set a more appropriate path as technology continues

to affect the rights of copyright holders.

II. History of Rights Management with Various Delivery Formats

1. *The birth of audio recording*

A history of copy rights in music requires a look at the first forms of music reproduction. The earliest form of musical reproduction was the traditional music box which traces back to the early nineteenth century. [12] Before the invention of the music box the public could only experience music through live performances. Music boxes gave the world the opportunity to hear music of their choosing at a time and place of their pleasure. Obviously, a music box does not replicate the actual timbre of the music as performed by a live performance artist; instead, it reproduces the melody and simple harmony of the composition through the timbre of struck metal tongues.

By the end of the nineteenth century the music box was basically replaced by the player piano – a device that allowed pianos to reproduce, note for note, previous piano performances. Eventually, more than 75,000 player pianos were sold, [13] and by 1902 over a million piano rolls had been sold. [14] Many such rolls were made by celebrity piano stars playing songs of famous composers on pianolas, which were prepared to record their every note. [15] The piano player rolls accurately captured the pitch and duration of the notes from the actual performance, while the playback device was responsible for the quality of the instrument and the intonation of the strings. Contemporaneous with the creation of the paper piano roll, its unauthorized duplication came into existence. A series of lawsuits by piano roll manufacturers against copiers of said rolls ensued and the holdings often favored the copiers. [16] The Supreme Court in *White-Smith Music Publ'g v. Apollo Co.* stated, “These perforated rolls are parts of a machine which, when duly applied and properly operated in connection with the mechanism to which they are adapted, produce musical tones in harmonious combination. But we cannot think that they are copies within the meaning of the copyright act.” [17] The furor over the player piano prefaced a forthcoming century of technological advances threatening the rights of copyright holders.

Actual replication of a live performance first occurred in 1861 and followed the development of the telephone. [18] Phillip Reis presented a lecture to the members of the ‘Physikalischer Verein,’ a physics organization, in Frankfurt, Germany entitled The Transmission of Tones via Galvanic Current over Wide Distances. [19] The first microphone was a thin diaphragm known as a contact microphone and the first “speaker cabinet” was the top of an old violin. [20] Reis demonstrated that melodies and spoken voice could be transmitted through electrical wires, which constituted the first time that a performance from one time or place was reproduced in another time or place – in this initial transmission, at roughly the same time and 200 meters apart. [21]

Sixteen years later, in 1877, Thomas Alva Edison added the remaining dimension of time when he created the wax cylinder recorder. [22] This crude device utilized a large horn into which the performance artist spoke (yelled), causing vibrations in a diaphragm at the narrow end of the horn. [23] Attached to the diaphragm, a needle dug into a piece of soft wax, impressing the vibrations of the diaphragm into the wax, recording the sound waves that hit the diaphragm. [24] This device was the earliest form of an audio recorder.

The wax cylinder would also represent the seed of piracy and sales of duplicated records. By 1900 an industry had already surfaced with the goal of selling copies of records. The layout and functioning of the duplication machines, as explained in the 1901 case, *Stern v. Rosey*, were identical in concept and layout to modern day cassette duplicators and CD duplicators:

Obtaining in this way a satisfactory record, which is called a “master record,” the defendant would place it in a machine called a “double phonograph,” and immediately below it another smooth or blank wax cylinder. The machine would revolve both, and by means of a double sapphire recording point the engravings upon the master record would be reproduced upon the blank cylinder. In this way defendant has produced as many as five thousand copies of the “master record” of complainants' music and songs, which are intended for use in phonographs. He has sold many of these and realized large profits from said sales. Complainants pray for an account of these profits, and for an injunction restraining him from further manufacture and sales, etc. [25]

The court in Stern, handling the case as a matter of first impression, found itself trying to analogize previous technologies (the player piano) to this new invention. [26] Ultimately, the court found that no copyright violation had occurred. [27]

In response to both Stern and similar rulings in player piano industry cases, [28] copyright holders pressured Congress to provide greater protection for music performances. In joint hearings before the Committees on Patents in both Houses on June 6-9, 1906, famed popular composers of the era, John Philip Sousa and Victor Herbert, complained that "manufacturers of music rolls and talking-machine records were reproducing part of their brain and genius without paying a cent for such use of their compositions." [29] Congress responded with the Copyright Law of 1909, designed to protect copyright holders' rights by providing them the exclusive right to "print, reprint, publish, copy, and vend" their works. [30]

2. *The birth of radio and music broadcast*

While Congress responded to the technological advances of the player piano and early record players, further progress in technology presented new concerns for music composers. In 1893 Nicolas Tesla invented the progenitor of the radio, starting the development of what would become the nation's new mass-media industry. [31] By the 1920s, the growth of the radio medium was frenetic. In 1922, 60,000 radios were purchased and by 1923 the number reached 400,000. [32] It is estimated that 6,000,000 radios were tuned in to hear Charles Lindbergh's return to America in 1927. [33] Along with the number of radios, the number of radio stations grew exponentially. [34] The low price of radio transmission equipment presented new challenges to copyright holders' rights. For example, a small radio station could rebroadcast a radio feed from another station, thereby adding its own advertisements and generating its own revenue, without "performing" the music on site through live performers or a phonograph and without specifically "copying" the performance. [35]

In 1931, the Supreme Court heard *Buck v. Jewell-La Salle Realty Co.*, one of the earliest cases to address the changing technology and its effect on copyright holders. The Jewell-La Salle Realty Co. owned and operated the La Salle Hotel in Kansas City, Missouri. [36] The hotel owned one radio set and wired outputs from the radio to all of the rooms in the hotel, supplying loudspeakers or headphones for the guests. [37] Among the material broadcasted throughout the hotel were songs that were copyrighted and licensed to a local radio station for transmission. [38] The Supreme Court found that retransmission of radio broadcasts to patrons constituted a "performance" under the Copyright Act of 1909. [39] The court ordered an injunction that prevented the hotel from distributing the radio feeds to individual rooms in the hotel. This conclusion was reached by analogizing the electro-magnetic transmission of a radio broadcast through speaker cables to the mechanical process of playing a phonograph: "Reproduction in both cases amounts to a performance." [40]

3. *Home recording becomes possible – the birth of the cassette tape*

The coupling of recording systems with radio created further concerns for the recording industry. Before this coupling, the legal rights of the artist with respect to unlicensed duplication of their work were legally irrelevant. By the 1910s, sales of the wax cylinder diminished as the flat disc phonograph flourished. [41] Phonograph duplication required expensive cutting lathes, [42] preventing consumers from doing the type of duplication referenced in Stern (where wax cylinders were duplicated and sold, prior to the prohibition of copying provided in the 1909 Copyright Act). Due to the cost, it was impractical for an end user to make a copy of purchased music. The "right" of the copyright holder to receive compensation for the distribution of their music was not only legally provided, [43] but it was inherent in the practical limitations of technology of the era. In time, however, technology improved the manufacturing of adequate fidelity reproductions with only a limited investment.

In 1963, the cassette tape was developed, [44] providing the consumer with a portable magnetic tape format based on magnetic tape recording systems that had developed over recent decades. [45] The low cost of cassette tapes and the availability of cassette recorders allowed end users to make recordings from radio, phonograph, or other cassette tapes, and with reasonable audio fidelity. [46] Underground piracy of cassette tapes and the ease of doing so again threatened copyright holders. [47] Congress responded with the Copyright Act of 1971, [48] specifically designed to curb piracy of sound recordings. [49] Even without this act, the characteristics of the

cassette tape would still leave the copyright holder with inherent, technologically supported rights, irrespective of the law. While reasonable replications could be made and cassette duplication machines became common household appliances, any duplication suffered an inherent degradation known as generation loss. The legal right exclusively reserved to the copyright holder to copy their material and to prevent copying by others was supported by a significant technological limitation, the inability to create a perfect duplicate copy.

The analog media used in cassette tapes has inherent limitations. [50] Not only can it not reproduce the entire audio range of human capabilities, but because of the multiple electrical and mechanical transducers through which the signal must pass en route from one piece of tape to another and because of inherent physical imperfections in these transducers, the signal passing from one medium to another suffers measurable change. [51] This change includes what is called “distortion” which may arise in many forms. [52] Distortion is separate from other types of signal degradation such as the attenuation of high frequency content, which often also accompanied cassette tape duplication. [53] Oftentimes, distortion manifests as a perceived increase in the level of noise on the tape. [54] In other situations the distortion manifests as “bleed” or crosstalk between tracks so that music from the B side of the cassette tape plays in reverse when the A side plays. [55] Distortion is also displayed in the form of “chirps,” “birdies,” or low level “hum,” all of which are tolerable depending on the listener and the amount of the distortion.

The level of distortion and other forms of signal degradation are inversely related to the quality, and thus the cost, of the duplication device. [56] It is impossible, however, to escape this signal degradation. [57] Further, the distortion becomes exponentially worse through multiple, serial copies. [58]

Due to this unavoidable signal degradation, the artist maintains some inherent protection through technological limitations. While an end user could copy and distribute material to his friends without compensating the copyright holder for the additional copies, each generation of copying and distribution suffered a loss in quality. If a prospective end user wanted the highest quality recording she had no choice but to purchase an original copy of the work from the copyright holder's legitimate distributors, which is duplicated for mass reproduction directly from the master tape, disc, reel or cylinder.

4. *The advent of digital audio.*

A. The development of the compact disc

In 1927, Harry Nyquist, a Bell Labs researcher, proposed a means by which numerical codes could represent signals such as audio waveforms. [59] By sampling the amplitude of the waveform at consistent intervals and storing them as numerical values, one could accurately recreate the waveform by decoding those digital values. [60] In order to be used for audio purposes, the waveform would have to be sampled several thousands of times per second to represent the frequency range that the ear can hear. [61] In the 1970s, technology finally advanced to allow this high-speed recording and saving of the numerical codes. [62] Sony and Philips collaborated on the first digital format and device adequate for mass consumption. [63] In 1982 they released the compact disc, a device that would change the audio industry.

The compact disc was carefully designed to provide a balance of features. It was physically small – (12cm diameter [64]), yet it contained enough data storage capacity to play seventy-four minutes of music, recorded in stereo and at very high fidelity. [65] The format of the audio on the compact disc was designed to provide transparent audio reproduction for the entire range of the human ear. With a sample rate of 44,100 S/s (samples per second), a compact disc can theoretically reproduce sound across a frequency range of well below the 20Hz lower threshold of hearing to higher than the 20kHz upper limit of human hearing. [66] Further, with a “bit depth” (representing the number of values between the top of the scale and the bottom of the scale for every sample taken) of sixteen bits, the compact disc could encode one of 65,536 different amplitudes for every sample. In other words, the “bit depth” on the compact disc would provide 96 decibels of dynamic range, [67] which is arguably beyond the capabilities of the human ear at any given time. [68] It is also beyond the range of most everyday listening conditions. [69]

The 44.1kS/s-sixteen bit capability of the compact disc also provided completely accurate phase response. [70]

The result was a system that has specifications wider than the response of the human ear across the entire range of hearing. The format itself could be said to be audibly “perfect.” [71] In comparison to the wax cylinder of Edison's era, the compact disc arguably provides nearly a million times the audio information, accounting for the increase in recording time, frequency response, and dynamic range. [72] Beyond the audible characteristics of the format, the compact disc was much more durable than previously released media for mass consumption. The disc was far more resistant to scratching and would not easily suffer detrimental change over time. [73] The compact disc entered the audio distribution market in 1982. [74]

For the first time, consumers purchasing a compact disc gained access to an audio playback device that was capable of meeting their audio needs and desires. Furthermore, by representing music numerically, the industry provided the consumer with a version of music such that copying would provide a 100% accurate replica of the original, resulting in zero generation loss. The saving grace for copyright holders was the sheer expense of purchasing the equipment necessary to manufacture a compact disc. [75] Holding as much as 680 million bytes, [76] the compact disc greatly exceeded the reach of computer memory in 1981. A compact disc contained approximately 2000 times the data that could be stored on the popular storage device of the era, the 5 1/4" floppy disk. Further, compact disc manufacturing required prohibitively expensive equipment that could create the micrometer-wide “pits” and “lands” on the compact disc media. [77] The Standard Stamper-Injection Molding method of making CDs (prevalent in the industry during the 1980s) requires a laser lathe that costs $1 million and involves a Class 100 clean room. [78] Only recently has it become possible to “burn” CDs at the consumer level. [79]

B. Digital Tape emerges and then promptly disappears, leaving behind the AHRA

In 1986, the audio industry released the first digital audio tape (DAT) machine, which provided the end user with a recordable digital audio storage system. [80] An end user would henceforth be able to make digital copies of music from a CD player or from another DAT tape machine connected with a digital cable streaming. [81] The DAT format introduced in 1986 provided “CD quality” sound using the same sampling parameters: 44.1kS/s - sixteen bit. [82] DAT machines equipped consumers with the first real opportunity to make digital copies without generation loss, [83] thereby upsetting the fragile balance of the copyright system. [84] Music industry insiders anticipated that DAT would replace the cassette tape as the dominant form of music delivery because of its size, quality, and the fact that it allowed consumers the ability to record and duplicate music. [85] Fearing a consequential effect on sales of legitimate albums and CDs as illegitimate “perfect” copies circulated, the music industry embarked on a two-prong approach to protect their copyright interests. [86] First, the industry threatened lawsuits against any company that marketed DAT recorders in the United States. [87] Second, the industry pushed Congress for assistance with copy protection. [88]

The result was the Audio Home Recording Act of 1992 (AHRA), [89] which took two steps toward protecting the rights of the copyright holders. [90] First, the Act required any digital audio recorder sold in the United States to include the newly developed Serial Copy Management System (SCMS) that was written into the DAT format. [91] SCMS (“scums” as it was disdainfully dubbed in the consumer industry) allowed the creator of a tape to control the future copying of the tape. Two bits, buried in the subcode of the tape, could be set at the time of recording to prevent anyone from copying the tape, restrict copying to only one generation, or permit copying at will. [92] Compliant machines would then allow the tape to be copied per the copyright holder's advance decision. If the copyright holder selected the one generation option, then any DAT recorder would set the subcode on all subsequent copies to prohibit copying altogether. [93] Attempts to duplicate a tape set to the option of no copying would yield an error. [94] As an additional benefit to copyright holders, the Act instituted a “tax” on all DAT machines sold in the United States in the amount of 2% of the trade cost of the machine with revenues dispersed to the record companies. [95]

While the DAT machine was released in 1986, only four years after the introduction of the compact disc, the threat of litigation prevented the machines from entering the market for nearly seven years. [96] By then the compact disc format was over a decade old and was well ensconced in American consumer culture. CD sales had surpassed sales of phonographs by 1988, [97] and many consumers started repurchasing their audio libraries in the CD format. [98] The DAT format never took off and was relegated to use in professional video and audio production environments. [99]

SCMS could be considered the first digital rights management (DRM) control used in the music industry. Prior to SCMS, rights management was accomplished constructively through the significant expense of duplication, generation loss, [100] and the threat of legal enforcement of existing copyright laws.

The AHRA affected any digital home recording device, covering a swath wider than the DAT recorder. For example, the MiniDisc recorder released in 1992, which did not catch on in the United States, was also required to have SCMS built into it. [101] Furthermore, when technological advances finally made it possible for consumers to "burn" contact discs, SCMS was required on all CD recorders and duplicators sold for home consumption. [102]

C. The computer, the CD, and the AHRA

By the turn of the millennium, the biggest threat for the music industry was not the DAT machine, the MiniDisc, or the CD player, most likely because SCMS limited consumers' uses of them. Instead, the concern was the consumers' ability to "rip" a compact disc's digital material directly onto their computer hard drives. [103] Once on a computer, a consumer's use of the disc's digital material was far less limited. The consumer could burn other CDs, listen to music catalogues directly from her computer's hard drive, use her wireless network to transmit her music directly to her stereo system, transmit music through the internet to her office, and send copies of her favorite songs to friends. [104] She could also use computer tools to compress the amount of data required for each song.

Compression technology results in a significant reduction of sound quality. [105] The decreased dynamic range, reduced frequency spectrum, and added distortion that result from such compression, however, are often undetectable when the consumer plays the music on traditional audio playback devices such as headphones, computer speakers, or other inexpensive hardware. [106] While with measurement equipment or even high quality home theater equipment an end user can often detect the difference between the original digital file and a compressed version of it, most consumers do not listen using this type of hardware and therefore find the differences to be inaudible. [107] Such compression formats include MPEG 1 Audio Layer 3 (MP3) and AAC, which is used by Apple Computer for iTunes, iPods, and the iTunes Store. Each of these provides around a 10:1 compression format, reducing the data size of an individual three-minute song from approximately thirty MB to three MB. [108] The original benefit of MP3 in the audio industry was to circumvent the rather small storage size of computer hard drives in the mid 1990s, when hard drives were typically around half a gigabyte. [109] At that time, the data stored on a compact disc was essentially the same size as a computer's hard drive. [110] Now, in the mid-2000s, when hard drives are typically hundreds of gigabytes and able to store hundreds of compact discs' worth of material, the benefit of continued use of compression formats is to circumvent the transmission bandwidth on the internet. [111]

Unfortunately for the audio recording industry, the Ninth Circuit Court of Appeals essentially exempted computers and computer hard drives from the AHRA. [112] In *Recording Indus. Ass'n of Am. v. Diamond Multimedia Sys.*, the court stated that a computer hard drive does not qualify as a "digital audio recording device" because audio recording is not the "primary purpose" of the hard drive. [113] Under this ruling, computer hard drives need not support SCMS. This effectively makes computers immune from the AHRA and provides users an easy means with which to make digital copies of their compact discs or the information on the discs. Because hard drives are immune from the AHRA, any digital media that does not involve some form of proprietary encryption is susceptible to importation into a computer and then copying ad infinitum.

Further, devices such as MP3 players, which are based on hard drives like those used in computers, are also not subject to the AHRA, and therefore do not require incorporation of the SCMS protocol. [114] Since users can circumvent SCMS through the use of computers and have all of the flexibility to copy the music they desire and due to the wide proliferation of computers in the United States, the AHRA is essentially old law that is inapplicable to the current environment.

A combination of the holding of Diamond and the inherent nature of the compact disc protocol would prove to be disastrous for the recording industry. Because the compact disc was designed when data rates and data storage were economically valuable resources, the compact disc audio data storage protocol, known as the "red book," has very little excess bandwidth to add new data. [115] The storage of data on the compact disc uses a fixed format of header bits and stereo-interleaved data bits, which are scrambled merely for the sake of data integrity in case of

scratches, modulated to preserve data integrity, and placed on the disc with a table of contents. [116] Six stereo digital words are assembled into a "frame" along with some synchronization bits (to identify the start of the frame) and eight accompanying "header" bits. [117] It is in this header area that the SCMS bits were utilized on DAT recordings. [118] By the time the data is prepared for the CD, only approximately one spare bit per digital sample remains unused on a red-book-compliant CD for purposes such as copy protection. [119]

The relatively small amount of spare, unused data on a CD, and the inapplicability of SCMS to computers leave the CD free to copy unless manufacturers resort to drastic measures. Several methods have been used by CD manufacturers to apply some sort of digital rights management with the scarce space available on the CD.

At least one record label started using "Copy Control" discs. [120] These discs use non-conforming table of contents and error correction data that exploit the differences between drives that are only required to read red book compatible digital audio data and those that are also required to read computer data, which uses the "yellow book" format. [121] When these discs do not conform to the red book standard they are disallowed from using the CD logo. [122] While Copy Control discs play without flaw in most consumer-grade, stand-alone CD and DVD players and while they are easily accessible in many computers, some computers have difficulty with the discs. [123] In France, a woman successfully sued the record company EMI for selling her a Copy Control disc because the disc would not play in her CD player and was thus found to be defective. [124] EMI was required to add a warning that the CD could not be played on all CD players. [125] Furthermore, Sony/BMG has used a technique called Key2Audio that also affects disc table of contents information which confuses the display abilities of some players. CDs with Key2Audio will be recognized on some CD players and inaccessible on other players. [126]

Another means employed by copyright holders is "digital watermarking." This technique involves adding theoretically inaudible, sonic information to the CD over the top of the music files. [127] The specific "sonic fingerprint" of the added audio signal can be identified, analyzed, and used for copy protection in various ways. One way digital watermarking can be used is simply to track copies to determine their source. [128] This method does not reduce copying directly as much as it indicates to a copyright holder who later finds an illegal copy on the market from whence the copy came. In this vein, watermarking is not a digital rights management tool as much as a research tool for investigating the flow of CD copies in the marketplace. [129] Watermarking is ineffective by itself in that a CD with a watermark can still be copied into a computer unless computer manufacturers voluntarily block the importation of data from CDs with particular watermarks. Computer manufacturers would likely be disinclined to add watermarking prevention to their hardware without economic incentive or legal requirements to do so. [130] Watermarking has been criticized for the audible effect it can have on music. [131] Many watermarking schemes have been audibly detected by scrutinizing listeners. [132] Watermarking does not inherently violate the red book protocol and, by itself, does not limit the abilities of the end user with respect to CDs. Watermarking does limit the abilities of the end user if it is incorporated into digital download files that use the "key" in the watermark to authorize the music for a given computer and exert digital rights management control. [133]

The methodology referenced in the Sony lawsuit from the introduction to this comment is perhaps the most controversial method employed by copyright holders to date. This type of digital rights management – the installation of files onto a computer that control use of the file [134] & ndash; has been used both by Sony BMG (by means of the XCP2 software) and by BMG (by means of MediaMax software). [135] The objections to Sony's scheme stem from both the software installed on unwitting computer users' hardware and the conditions of the shrink-wrap licensing agreement included with the CDs. [136] The results from Sony BMG's digital rights management were disastrous. [137]

D. The recording industry pushes to replace the CD

The compact disc passed its twentieth anniversary in 2002. Moore's Law indicates that technology doubles in speed, internet capabilities, and memory every twenty-four months. [138] Thus, logic would dictate that soon enough the compact disc would be replaced by something more capable and useful as technology progresses. The recording industry has pursued the successor to the compact disc since soon after its release. [139] It has long been suspected that some format of tangible media would eventually replace the compact disc as a way of supplying music to the consumers. [140] Some pursuits for a successor to the CD stemmed from desire to improve sound quality. [141] While the compact disc format of 44.1kS/s - sixteen bits was sufficient to represent the entire range of

human hearing in frequency, dynamic range, and phase, compact disc players were unable to provide this level of performance. [142]

The traditional means of decoding the binary numbers on the compact disc involved a digital-audio converter (DAC) that used a system called an R-2R resistor ladder. [143] Early R-2R converter designs were, by themselves, able to provide a frequency range superior to that of cassette tapes and phonographs. [144] Digital converters, however, require filters to prevent a type of distortion called "aliasing." [145] These filters cut off some of the available range of the compact disc – in early generations by as much as an octave. [146] The industry soon thereafter developed "oversampling" converters that temporarily increased the sample rate and used digital filters to prevent aliasing rather than filters made from analog components. [147] Digital anti-aliasing filters have several advantages over their analog counterparts, including the ability to maintain the upper octave of human hearing. [148] Early digital anti-aliasing filters still suffered sonically due to the sheer expense of the microchips required to perform the tasks. Digital converters that are arguably audibly transparent only emerged in the market in the mid-1990s. [149] The easiest and most available substitute in the mid 1980s was to increase the sample rate above 44.1kS/s – perhaps to 88.2kS/s or 96kS/s (to conform to the 48kS/s sample rate used in film). The audio engineering industry started to experiment with 96kS/s equipment in the mid-1980s, and use of 96kS/s compatible equipment became prevalent in the audio recording market by the early 2000s. [150]

R-2R ladder converters also proved insufficient to represent the dynamic range of the human ear, often providing only around 75dB of dynamic range which is approximately 20dB less than the inherent capabilities of the compact disc format. [151] While substantially better than the roughly 70dB available through the phonograph, [152] and the roughly 55dB [153] audibly discernible through cassette tapes, the compact disc's converters fell short of the eventual goal of providing a technology that could reproduce audio transparently for the human ear. The industry made great strides in improving the dynamic range capabilities of digital audio converters by using one-bit delta-sigma modulator converters. [154] These converters emerged in the audio industry in the mid-1980s. [155] Twenty-four bit recording devices using delta sigma modulator converters strongly emerged in the audio recording industry in the late 1990s. [156] These devices provided the audio recording engineer with in excess of 110dB of usable dynamic range on the recording side. [157] This dynamic range represents well more than the range which the human ear is capable of recognizing. [158]

Through the use of twenty-four bit and 96kS/s equipment on the recording side, the recording engineer could overcome the hurdles of sixteen bit and 44.1kS/s equipment. It seemed inevitable that a new audio release format would emerge to provide this level of data to the consumer and thus overcome the shortcomings of the equipment used to play the compact disc. [159] By the mid-1990s there were requests in the audio recording industry for a twenty-four bit - 96kS/s recording and playback system, designed so that the converters used to convert the digital data back to analog could provide the complete capabilities of which the sixteen bit 44.1kS/s format were theoretically capable. [160] Any increase in sample rate or bit depth would require more data storage ability in order to hold an entire album's (seventy-four minutes) worth of songs. [161] The digital versatile disc [hereinafter "DVD"] was released in 1996 and provided more than twenty-five times the capacity of the compact disc using a device of the same physical size but with multiple layers and data more densely packed on the disc. [162] Two factions emerged in the audio recording industry to provide a new audio delivery format that would take advantage of the increased storage ability of the DVD.

The DVD Forum's Working Group 4 (WG-4) combined efforts of an amalgam of record labels and hardware manufactures and attempted to provide a format that would meet multiple needs of consumers. [163] The resulting format, dubbed "DVD-Audio," was introduced to the market in 2000. [164] DVD-Audio provided the author with multiple options for how to utilize the media's capabilities. [165] An author could put music on the disc in a variety of bit depths from sixteen to twenty-four and a variety of sample rates from 44.1kS/s to 192kS/s. [166] The DVD-Audio format also supported surround capabilities with six channels standard. [167] The format also supported video clips, menus, more recording time for a compact disc. Each of these options is flexibly determined by the author. [168] Of great benefit to the recording industry is the prospect of the financial boon that lies ahead when consumers repurchase their audio libraries in the new, "superior" format. The recording industry benefited from this boon when the compact disc replaced the phonograph and many users repurchased their favorite albums on the new format. [169] The DVD-Audio's other great benefit for the recording industry was the addition of digital rights management encryption to the disc. [170]

DVD-Audio utilized a multi-prong approach to rights management. [171] At first, early DVD-Audio players did not contain any form of digital output. [172] This prevented a consumer from connecting the digital output from their DVD-A player to some form of digital recorder. Furthermore, this player precluded the consumer from copying the information directly. The player only contained analog outputs that were to be hooked directly to the consumer's playback system – any recording of which would endure generation loss. [173]

The disc also contains software licensed by 4C Entity that prevents copying the disc when using a computer. [174] DVD-A discs (like other formats of DVD discs) can utilize digital watermarking to trace and help investigate digital piracy. [175] Later, DVD-Audio players did have digital outputs but the digital signals were encrypted before exiting the player and decoded by a legitimate, licensed receiving device using watermark technology. [176] DVD-Audio copying is regulated by systems similar to those of SCMS in that the disc incorporated a code buried in subcode that indicated any preset restrictions on copying. [177]

The Super Audio Compact Disc [hereinafter “SACD”] project stemmed from a joint effort from Sony and Philips. [178] SACD was an outgrowth of Sony's work on delta sigma modulator converter technology in the 1990s and uses the data format internal to analog-digital conversion chips. This format sampled at one bit but at 2.8224 GS/s (128 times the 44.1kS/s sample rate of CDs) and with noise-shaping was dubbed “Direct Stream Digital” [hereinafter “DSD”] which became the basis for the SACD format. [179]

The SACD format is also author-flexible like the DVD-A format where authors may release SACDs in stereo or surround and may also add a traditional CD track to the disc. [180] The benefit to the consumers was supposedly an increased sound quality and the opportunity to play their music in a surround-sound environment. The benefit to copyright holders was again the rash of consumer purchases of music already owned in the older format that will hopefully be repurchased in the new format and the addition of digital rights management. [181] The SACD format has very robust copy protection technology built into it, including watermarks that are only recognizable by licensed SACD players and pit modulation called Pit Signal Processing (PSP). [182] The discs cannot be played in computers and Sony has strict licensing protocols for SACD replication facilities so that discs cannot be created except by their facilities. [183] Until recently, SACD players did not include a digital output which forced consumers to connect their SACD players directly to their analog amplifiers for playback. [184] Recently, digital outputs have been added but the data is encrypted and only usable by a licensed decoding device such as an approved, Sony-licensed audio processor. [185]

The SACD and DVD-Audio have been in a format war since they were mutually released at the turn of the millennium. [186] Each format touts superior audio to the 44.1kS/s – sixteen bit CD standard released in 1982. Each format sports additional features that are friendly to the user including longer playback time, surround capabilities, and the option for video features. The reasons for the stalled adoption of either format by the consumer market are multifold. First, format wars tend to scare consumers away until a victor emerges. [187]

Second, the sound quality marketing was unsuccessful. While Sony, Philips, and the consortium of DVD-A supporters were creating formats that supported higher bit depths and sample rates to overcome the problems with compact disc playback devices, the digital-audio converter manufacturers were fixing the problems with previous generations of players. Since 2000, compact disc players have provided 96dB of dynamic range, reproducing the entire frequency spectrum of audible hearing. [188] In other words, the compact disc players can now do what the compact disc format was inherently capable of doing when it was created in 1982 – provide audibly transparent recordings to the human ear. Discerning listeners who are willing to pay the price for new hardware may simply upgrade their CD players to get the same audible results as adopting a new format entirely.

The DVD-A format has also suffered from what industry analysts call the “too many chefs in the kitchen” syndrome, wherein the release of the format was protracted because of negotiations amongst the various parties and interests involved, and the resulting release was overly complex. [189] Sony's DSD format probably suffered from the numerous industry trade group discussions and presentations about its shortcomings. The format's one-bit methodology results in inherently low-level distortion that has been the subject of a tome's worth of whitepapers by researchers. [190]

While both DVD-A and SACD manufacturers and record labels designed a marketing blitz about the sound quality benefits of these two formats, the press appears to have fallen on deaf ears – literally. Apparently users cannot hear the difference. This is not surprising for multiple reasons such as the sound quality of the compact disc and compact disc players (even lackluster ones) which often exceeds human hearing abilities for the environments in which people play their music. [191] For discerning listeners with money to spend on improving their sound quality, modern CD players often meet their needs. [192] Finally, any audible differences purported by the manufacturers to be inherent in their respective formats have been unsubstantiated by scientific research.

When consumers weigh this sound quality issue with the expense of upgrading their hardware, the difficulty of upgrading their hardware (i.e. replacing a car stereo system), the inherent limitations of the new formats due to their digital rights management, and inability to copy the music to play in more convenient environments such as on portable players explain why the two competing formats have failed to attract consumers. [193]

E. A successful new format emerges

While the DVD-A consortium and the Sony-Philips SACD team worked to create a format to replace the compact disc, the actual replacement appears to have originated from what was at the time the most unlikely of places. On April 28, 2003, Apple Computer unveiled the iTunes Music Store, [194] an online music store that initially provided 200,000 songs and albums available for download purchase [195] for less than their comparable price on compact discs. [196] By 2004, Apple Computer offered 1,000,000 songs available for download as sales continued to accelerate. [197]

The success of the iTunes music store can be attributed to the support from the copyright holders, the flexibility for users, and the minimal cost. The cost of initial investment is nominal for computer users. The program itself is free, the songs are cheap, and users typically listen to music on their normal computer speakers. For the price of an iPod, which started at $299, users could play the music on a small, portable device that could archive hundreds of songs' worth of music for playback in a car or with headphones. [198] With Apple's Airport Express at $129, users could wirelessly transmit their music around their house to the family stereo system. [199] iTunes is not limited to items purchased through the Apple Music Store – users can import all of their own CDs into their computers and catalogue all of their previous purchases together with music they purchase at the iTunes Music Store

The advantage of iTunes to copyright holders is Apple's digital rights management system, FairPlay. All songs purchased are encrypted and contain keys that restrict their playback to a fixed number of computers and further restrict their playback to Apple hardware. [200] Users of portable music players other than Apple's cannot play music purchased from the iTunes Music Store. [201]

Perhaps the greatest lessons learned from the Apple iTunes story are as follows: 1) the sound quality of the compact disc or lesser formats such as the data compressed formats used in MP3 players in the typical listening environment is of less significance to the end user than the convenience of listening to music at their discretion; 2) despite the “free” (illegal) copies of music are available for download on the internet, a substantial number of users are willing to pay a reasonable fee to obtain music when it is coupled with their desired flexibility and a large selection of available music choices; and 3) a substantial number of users are willing to endure a certain level of digital rights management when coupled with the ability to have the music on their own computers and portable listening devices. It is with these realities in mind that one cannot be surprised that the DVD-A and SACD formats have failed to garner consumer demand.

Whereas other formats that contained digital rights management systems were unsuccessful (DAT, MiniDisc, SACD, and DVD-A), Apple succeeded because the music that contained digital rights management information was sold or resold to the consumers with added features that the consumer wanted: ease of purchase and the fact that the music was pre-prepared for their computer-based listening systems. Nevertheless, releasing all music through internet stores that add digital rights management systems does not provide an end-all solution.

F. Congress provides protection for post-CD music delivery formats

In 1996, the World Intellectual Property Organization [hereinafter "WIPO"] passed the WIPO Performances and Phonograms Treaty (WPPT) [202] and the WIPO Copyright Treaty [203] (WCT). The United States Congress ratified these treaties and executed them through the Digital Millennium Copyright Act [hereinafter "DMCA"], passed in 1998. [204] The DMCA was designed to update United States copyright law to conform to the advances of technology. [205] In addition to addressing internet service providers and internet copyright infringement, [206] the DMCA also provides significant protection for "technological protection" measures used to protect copyrighted information. [207]

The technological protection provisions of the DMCA protect both "access controls" [208] and "copy controls." [209] Access controls include any form of digital rights management that controls when and how users might exert the rights to enjoy or use copyrighted works they have acquired, such as encryption, certain types of watermarking (such as for verification to decrypt encrypted files), or the type of pit modulation used by Sony on the SACD. Copy controls measures are a form of digital rights management that prevent copying of material, such as XCP software, MediaMax software, and the SCMS system advanced by the AHRA.

The DMCA provides protection to access controls by making it a violation of the act to "circumvent a technological measure that effectively controls access to a work protected under this title." [210] The DMCA protects both access controls and copy controls by providing criminal sanctions for those who "manufacture, import, offer to the public, provide, or otherwise traffic in any technology, product, service, device, component, or part thereof" that is designed specifically to defeat any technological measure that "effectively controls access to a work protected under this title" [211] and also any technological measure that "effectively protects a right of a copyright owner under this title." [212]

The DMCA provisions do not prohibit a device that would defeat SCMS. SCMS is not an access control technology, as its use in DAT players and as prescribed in the AHRA do not in any way limit the user's access to music on the DAT tape or CD drive. [213] SCMS is purely a copy control technology and as such only falls under the provision of the DMCA that prevents the manufacture, import, providing, or trafficking in technology that defeats the SCMS system. While the DMCA does not provide a definition of "technological measure," it does explain that such a measure "effectively protects a right of a copyright owner" if "in the ordinary course of its [the technological measure's] operation, prevents, restricts, or otherwise limits the exercise" of copying music. [214] Because SCMS as implemented uses technology to restrict the copying of music, the manufacturing or otherwise trafficking in a device, technology, software, or a process to defeat SCMS would be a violation of the DMCA.

While the DMCA provisions provide only limited protection for SCMS technology, they provide more robust protection for software and other control means used on both SACD and DVD-Audio discs. Both of those types of media provide both copy control technology and access control technology, and the technologies are intermingled. [215] Whereas SCMS prevents the copy of a digital file, the DVD-Audio specification allows a playback device to send digital information such that a copy can be made, but the copy itself will be inaccessible due to the data's encryption. [216] The promulgators of these formats clearly created formats that were both difficult to defeat and legally protected from circumvention.

The iTunes Music Store digital rights management software, Fairplay, is also protected by the DMCA. It also bridges the gap between access control and copy control. While Fairplay software does not prevent a consumer from making a copy of a file downloaded off of the iTunes Music Store and putting it in an unauthorized device, it prevents access to the copied file. [217] As such, files downloaded from Apple Computer appear to have the full protection of the DMCA's access and copy control measures.

Each of the three intended replacements for the compact disc has a type of digital rights management system that is protected by the DMCA. In the SACD format, there has been no public disclosure of any successful circumvention of the digital rights management measures. In June 2005, a hacker managed to circumvent many of the tools used in the DVD-Audio format and had posted his circumvention tools to a website. [218] Shortly thereafter, under provisions of the DMCA, the tools were removed from the website. [219] Apple's iTunes system has also been hacked, [220] but as proffered on the DRM Watch website, the mere existence of a hack "does not

necessarily mean that all files packaged in that DRM are suddenly out in the open." [221] Any such hack does not appear to be significantly affecting the market for iTunes products as the sales rate at the iTunes Music Store continues to accelerate. [222]

The compact disc, however, has no digital rights management protection under the DMCA. The compact disc audio format as codified by Sony and Philips (the red book) and asserted by Phillips in court does not tolerate and is not compatible with any digital rights management software. [223] Digital rights management software is anathema to the compact disc digital audio format. Any digital rights management provision included on the disc renders the disc no longer a "compact disc" but rather a disc closely resembling a compact disc that cannot be played by all red book compatible compact disc players; ergo, not red book compliant. It is with this history and framework in mind that it becomes clear why copyright holders in the forms of record labels and manufacturers of otherwise-CDs (five-inch radial discs that are similar to CDs but fail to conform to the specifications of CDs) are embarking on drastic measures to protect information on the discs. While the actions of Sony BMG should not be condoned since digital rights management software should not damage equipment of abiding consumers, a solution is required in order to preserve the rights of copyright holders at a time when technology has advanced to the point that those rights have been effectively eliminated by advances in technology.

III. ADDITIONAL DIGITAL RIGHTS MANAGEMENT SYSTEMS ARE NECESSARY DESPITE THE SUCCESS OF DRM-LADEN ONLINE DOWNLOAD DISTRIBUTION

1. *The music industry within the United States requires Digital Rights Management to control piracy within the United States*

The compact disc is still the dominant delivery medium for music. [224] At the end of 2005, US compact discs were selling at 705.7 million per annum. [225] Annual sales of online music, such as iTunes, reached 50.29 million albums at the end of 2005. [226] While CD sales are dropping and online sales are increasing, the two are not necessarily inversely correlated. CD sales have been dropping annually since 2000. However, the 8.0% decrease in sales between 2004 and 2005 was not as severe as the 8.9% decrease in sales between 2001 and 2002, prior to the advent of online download retailers. The compact disc still accounts for roughly 72% of all album sales, whereas online downloads account for only 5%. [227] It should be noted that combined sales of DVD-A and SACD releases in 2005 fell 9% to 1 million albums, accounting for a mere .1% of all album sales. [228] Following current trends of both CD and online download sales, online sales will not surpass the CD for several years at minimum.

Since the compact disc is still the dominant music delivery medium, it still does not contain DRM, and the currently developed DRM schemes either damage consumers' equipment [229] or are unable to work in all consumers' CD players, [230] the music industry requires a legal, harmless form of DRM for the CD format in the United States.

2. *The music industry within the United States requires Digital Rights Management to control piracy outside the United States*

Internationally, online download sales are likely to stagger behind tangible-medium (CD and cassette) sales. 20% of the world's population accounts for 80% of the world's PC and internet users. [231] Online distribution cannot increase beyond that of the world's Internet connectivity. While connectivity is ubiquitous in the United States, Europe, and Japan, it lags far behind in the world's most populous regions. [232] Nevertheless, these regions buy significant quantities of music. In 2003, the developing regions of the world purchased 27.7% of the world's music, accounting for a total of 720 million albums – nearly equivalent to the US domestic market alone. [233] Of this total, more than half the sales were on the now seemingly antiquated cassette tape, further indicating the likely lag in time before Internet download distribution becomes the worldwide norm. [234] Globally, the pre-digital cassette sales still account for 18% of the world's music sales. [235] Digital download sales account for only 5% of the global market, the vast majority of which are mobile ring tones rather than complete songs. [236]

International trade in music is important to the United States

International trade in music is important to the United States because of its impact on the US economy. The United States reaps significant revenue from our export of intellectual property throughout the world. In 2003 the trade balance on intellectual property provided the United States with a surplus of $28.2 billion on total receipts of $48.3 billion. [237] This surplus represents an increase of approximately 5% over 2002 figures. These numbers are not surprising. Since 1982, receipts on US intellectual property have increased nearly every year. [238]

According to a study commissioned by NBC Universal, the United States intellectual property industries, including the entertainment, software development, pharmaceuticals, and other related industries, contribute nearly 40% of the growth achieved by all U.S. private industry, are responsible for 20% of the total U.S. private industry's contribution to the U.S. Gross Domestic Product, and are the largest positive contributors to the U.S. balance of trade by totaling $33 billion in net export revenues for 2003. [239] Of the $33 billion in export net revenue generated by the core copyright industries, approximately $11 billion is accounted for by the music and film industries in annual export net revenue for the United States. This net value of the entertainment industry to the US economy has grown consistently over at least the last six years. [240]

Further, the core copyright industries of film and music consistently employ approximately 400,000 workers. [241] The popularity of employment in the film and music industries continues to increase while the number of workers in other sectors is in decline. [242] Since US music and other copyright industries are accruing positive trade revenue, it is important that the US focuses on the needs of these industries in order to improve their revenue streams and continue to bring a benefit to the US economy.

International trade in music is also important to the US because of our support for developing nations. In 2000, President Bill Clinton, along with heads-of-state of more than 100 other countries signed the United Nations Millennium Declaration, creating the Millennium Development Goals. [243] The goals have an overall objective of supporting human rights through reduction in warfare, care for the environment, and eradicating poverty and disease. [244] A primary thrust of the goals centers on the needs of developing countries. [245]

Many developing nations are poor in economics but rich in culture and tradition. [246] One way to increase the wealth of developing nations is to allow them to exploit their culture and tradition for financial gain. [247] Nowhere is this easier than in the music industry where digital files can be sent to foreign countries via the internet for pressing at CD pressing plants. Many developing countries have large Diaspora populations in the US, and these populations purchase significant quantities of music from artists in their homelands. [248] Diaspora populations also help spread the popularity of artists in their new countries. [249] Allowing author-flexible digital rights management on CDs in this country would allow authors in developing countries to either limit “free” distribution of their music in the United States or would give them the opportunity for compensation for their work. Compensation at this level can have a significant effect on music industries in developing nations. [250]

Further, since music piracy is rampant in many developing nations [251] other nations would most likely adopt similar SCMS laws once the format is in place and discs are encoded with SCMS codes. This adoption of similar SCMS laws would greatly benefit developing countries because their music industries often suffer significantly due to piracy. [252] Controlling piracy of their own material in their own countries would naturally boost their economies. Once developing countries work to curb piracy domestically, US copyright holders who export into those markets would benefit.

3. *Lack of effective digital rights management in the audio industry has an effect on other intellectual property industries*

In addition to the audio industry, other industries are also suffering due to technology's advancements and the slow Congressional response. The film and video industries are waiting the settling of the audio industry instability before they release their wealth of content in ways that are more flexible for consumers. [253] The success of iTunes has some television studios releasing syndications of their previous shows for sale on the iTunes Store. [254] The film industry, however, is pushing for more effective control of peer-2-peer file sharing on the internet while it sits on its vaults full of unquestionably lucrative digital content. [255] Even the CEO of TiVo, the ubiquitous set-top box that allows users to record movies and TV shows for later viewing, states that management of copyright (i.e. digital

rights management) is the concern for the film industry as the era of prevalent movie downloading draws nigh. [256] While the DVD-Video format has inherent digital rights management in the form of the Content Scrambling System (CSS), an encryption system, [257] the video industry watches intently as the music industry resolves the kinks of digital rights management issues. [258]

Other creative industries have their own digital rights histories, distinct and separate from audio and video. The publishing industry has its own digital rights management legal issues for its schemes developed primarily for online distribution. [259] Due to the analog nature of printed media such as books and the cost of duplication, the threat of piracy of the tangible media is much lower. Print media and the audio industry merge on the issue with respect to audio books, or what are archaically still known as "books on tape."

The computer software industry also uses digital rights management for its products but in different circumstances. Software is generally sold under a license which limits its available uses under contract with the purchaser. [260] Software engineers can plausibly write a license that conforms specifically to the digital rights management scheme they utilize, or vice versa. Music, film, books and other creative products are generally sold outright under the "first sale" doctrine, providing the consumer with the right to use the product in any matter that conforms to copyright and other areas of the law. [261] Further, consumers have the right under the first sale doctrine, and in combination with the Copyright Act of 1976, to use the purchased copyrighted material under the terms of "fair use," allowing the consumer the legal exceptions to the copyright act in some situations. [262] Since fair use is a broad concept that has yet to yield specific rules, it is difficult or even impossible for copyright holders to implement digital rights management that preserves the right to copy for the copyright holder while also providing for the myriad exceptions to that right that are granted to the consumer under fair use.

Even though software and other creative products yield differing digital rights management issues, the ramifications of the recording industry's attempts to use digital rights management will assuredly have an effect on these industries as well. Software engineers are watching the developments of the Sony BMG XCP software debacle and other attempts at digital rights management in the recording industry as they further develop their own schemes. Decisions of Congress or the courts that either reinforce fair use at the consequence of copyright holders' rights or those that boost the rights of the copyright holder despite fair use with respect to media in the recording industry are bound to be used as precedent for the same questions in other industries.

IV. FIXING THE PROBLEM

1. *Who should bear the responsibility?*

The lack of digital rights management should not fall solely in the hands of the rights' holders. While indeed the CD was pushed onto the market by copyright holders (in the form of record companies) and while they made significant profits from re-purchases of existing libraries during the CD's market infiltration, it would be preposterous to assert that the early developers of the compact disc should be faulted for lack of anticipation in a rapidly changing world of technology and advancement where twenty years later some form of digital rights management would be necessary. The developers of the compact disc should also not be faulted for its abundant success and thus the adoption of the CD as a data archive format in the computer industry, requiring low-cost CD burner development that would allow for compact disc duplication and the type of data fluidity that would eventually be the bane of copyright holders. The developers in 1982 should also not be faulted for failing to anticipate the future development and various uses of the emerging personal computer. [263]

It would be equally preposterous to leave the solution to digital rights management entirely within the hands of copyright holders. Not only is it nearly impossible to cure the widespread downloading and dissemination of music through civil remedies, but the policies of this country have pushed for the type of open internet and technological advancement that yield the type of abuse at issue. Remedies for the intractable shortcoming of the CD to secure rights to the copyright holders who release music on it must come from a source beyond that of its developers or those who are virtually forced by market demand to release music on it.

It is the role of the government to ensure that the rights of its citizens are upheld. [264] In terms of copyright

law this responsibility falls on the Congress. [265] Congress should learn from its passage of the AHRA what was successful and where the statute may have failed. The failure of the AHRA to produce a legally sound form of digital audio tape could be attributed to Congress's passing the bill once the market for DAT had already collapsed. It would be prudent for Congress to provide a remedy for the loss of copyright holders' rights of music on CDs before it is too late – a time that, if not already passed, is rapidly approaching.

2. *How can Congress maintain the digital rights of copyright holders?*

Congress should consider fixing the problem created by the Court in its Diamond Rio ruling by updating the AHRA to include computers and computer peripherals as "home recording" devices. [266] Statistics show that a substantial number of internet users download files illegally. [267] By updating the AHRA to require that computer-based CD and DVD drives support SCMS, Congress can provide much needed increased security in the United States for copyright holders' rights. Congress could also make CD drives for computers subject to the "tax" provided for by the AHRA. Since most CD drives are now CD/DVD drives, some of the revenue may appropriately need to be shared with the similarly concerned video industry.

By updating the AHRA to require SCMS compliant computer hardware, Congress would also bring that hardware under the copyright protection of the DMCA. It is a violation of DMCA copyright law to circumvent technological protection measures such as SCMS.

Currently, with any red book compliant compact disc that will play on any red book compliant CD player there is nothing to prevent the end user from importing the CD into the computer. Further, only civil damages are available if a user disseminates the material to others outside the bounds of fair use. [268] If a CD contains SCMS, however, and computer-based CD drives are SCMS compliant, then the casual computer user will be prevented by software from importing the CD into the computer unless the copyright holder authorizes it. The user will further be deterred from defeating that software by the DMCA's regulation of circumvention of technological protection measures such as encryption. The DMCA will also deter the user from acquiring software to defeat the SCMS protection. Finally, the user will be deterred by lack of need. SCMS would allow the user to listen to the software using his computer CD drive, to import the music into the computer's hard drive, and to put the music on a portable, personal listening device. Since SCMS is not statutorily codified to the methodology used with DAT tapes, a SCMS approach for the compact disc could utilize more bits and regulate use to more than a single computer and portable listening devices that are "registered" to the user's authorized computer or computers. [269] This use of the subcode bits to create a digital rights management scheme would not violate the red book format in that all red book compatible CD players could read the data and play the music. Devices including computers that record the information would be restricted from copying the data. A combination of an updated AHRA and DMCA in this manner would provide significantly more protection and rights management than is currently available, unless further drastic measures are taken or record companies release more non-red book compliant CDs. This combination also plausibly does not interfere with the rights of the consumer. Congress should also consider updating copyright law to expand criminal penalties for copyright violations. Currently it is a crime under the DMCA to circumvent technological protection mechanisms used to control access or copying, but only when the use is done "willfully and for purposes of commercial advantage or private financial gain." [270] A significant part of the marketplace for downloads of copyrighted material is freeware, or that which provides no financial gain and is merely done as a gift to a shared internet community. The DMCA does not address this trend and merely targets exploiters of fiduciary benefits. Updating the AHRA to add SCMS to computer related peripherals should be accompanied by making circumvention of SCMS subject to criminal penalties. These two updates would serve as a way of demarcating the difference between freely sharing copyrighted material and consciously providing software or tools that allow another person to break the law. It would be too easy to write software that would alter the SCMS data in red book compliant files imported into a computer from a CD to allow the benevolent software hackers who intentionally help others skirt copyright law to avoid criminal liability for their crimes. Expanding copyright criminal law would show an acknowledgment by Congress that a robust intellectual property industry is a significant public policy interest of the United States.

Some may allege that simply requiring CDs and CD playback devices to conform to SCMS would be easily defeated and therefore ineffective. First, simply requiring SCMS does not necessarily require the form of SCMS used in DAT machines. Assuredly, this type of copy protection would be easily defeated. [271] A SCMS format for

CDs could involve bit settings that instruct the computer upon importing the disc to encrypt the files on the computer as a local server, thereby keeping the files on the CD compliant with the red book but instructing the computer to protect the data with local encryption software required for compliance by the statute in such a case as the CD is copied to the computer hard disk.

Even if the measures are surmountable and small-time software engineers write code that circumvents the copy protection measure in violation of the law, these measures are not ineffective. As indicated by the iTunes Music Store phenomena and the fact that engineers have hacked its digital rights management system and provided the results free of charge, [272] the mere fact that the technological protection has been defeated does not inherently mean that the users will take advantage of the circumvention method. As alleged on the DRM Watch website, the lesson to be learned from Apple is that if the digital rights management technological protection measures are fair, users will be less inclined to take advantage of readily available circumvention technologies. [273]

V. CONCLUSION

In the last 100 years the United States has gone from a situation wherein the right to prevent the copying of music was legally allowed but technically preserved to a situation wherein that right is legally preserved but technically allowed. At multiple points along the way, copyright holders have attempted to interrupt this transition. For a short time, SCMS made it nearly impossible to copy music. By 2006, the vast majority of music performance copies is both technically impossible to stop and legally impossible to enforce. Until the market shifts entirely to a technologically protected format it is clear that the exclusive right of the copyright holder to copy music is constructively nonexistent. It is within Congress' purview and ability to curb the trend and the time is now for Congress to act for the interest of the intellectual property industry.

[1]. In re Sony BMG Audio Compact Disc Litig., 429 F. Supp. 2d 1378, 1379 (J.P.M.L. 2006); *See also*, Tom Zeller, Jr., Sony BMG Sued Over CD's With Anti-Piracy Software, N.Y. TIMES, Nov. 22, 2005, at C6.

[2]. XCP2-Aurora eXtended Copy Protection, http://www.XCP2-aurora.com (last visited July 25, 2006); *See also*, Posting of Mark Russinovich to Mark's Blog, Sony, Rootkits, and Digital Rights Management Gone Too Far, http:// thnlnk.com/technet/0000002801 (Oct. 31, 2005, 11:04 GMT) (revealing the presence of the Sony BMG rootkit software in question on his hard drive, discussing the difficulty in removing it and the user's susceptibility to viruses as a result of this software).

[3]. In re Sony, 429 F. Supp. 2d at 1379.

[4]. BBC News, Sony recalls copy-protected CDs, http:// news.bbc.co.uk/2/hi/technology/4441928.stm (Nov. 16, 2005 12:08 GMT) (reporting Sony BMG's recall of all CDs that contain XCP2 software); Sony BMG Music Entertainment, CDs Containing XCP2 Content Protection Technology, http:// cp.sonybmg.com/XCP/english/titles.html (last visited July 21, 2006) (listing the fifty-two albums affected by the XCP2 software); see, e.g., BBC News, Sony stops making anti-piracy CDs, http:// news.bbc.co.uk/2/hi/technology/4430608.stm (Nov. 12, 2005 06:05 GMT) (reporting Sony BMG's decision to stop producing CDs with XCP2 technology and tracing the two-week history of the fiasco starting with the Russinovich Blog).

[5]. See Russinovich, *supra* note 2, at 5.

[6]. Iain Thompson & Tom Sanders, Virus writers exploit Sony DRM, http:// www.vnunet.com/vnunet/news/2145874/viruswriters-exploit-sony-drm (Nov. 10, 2005) (reporting a virus emailed to computer users in the UK that exploits the Sony BMG XCP2 software and explaining how the virus works).

[7]. Current Activity, US-CERT, First 4 Internet XCP DRM Vulnerabilities (November 14, 2005), http:// www.uscert.gov/current/archive/2005/11/17/archive.html#xcpdrm.

[8]. Attorney General of Texas Greg Abbott, Attorney General Abbott Brings First Enforcement Action In Nation Against Sony Bmg For Spyware Violations, http://www.oag.state.tx.us/oagnews/release.php?id=1266, (Nov. 21, 2005) (announcing a lawsuit filed under Texas's spyware laws, contending that the software installed on Sony BMG's CDs was, by legal definition, spyware, and thus illegal in the State of Texas); *See also*, In re Sony BMG Audio Compact Disc Litig., 429 F. Supp. 2d 1378, 1379 (J.P.M.L. 2006).

[9]. BBC News, Sony sued over copy-protected CDs, http:// news.bbc.co.uk/2/hi/technology/4424254.stm (Nov. 10, 2005 11:22 GMT) (reporting the filing of a lawsuit in California and the expected filing of one in New York, in addition to actions by the Electronic Frontier Foundation in possible preparation of a lawsuit).

[10]. In re Sony BMG Audio Compact Disc Litig., 429 F. Supp. 2d 1378, 1379 (J.P.M.L. 2006)

[11]. Letter from Associazione per la libertà nella comunicazione elettronica interattiva [Association for Freedom in Interactive Electronic Communication] to Comandante Col. Umberto Rapetto of the Guardio di Finanza Nucleo Antifrode Telematica [Financial Police Department for Fraud in Data Transmission] (Nov. 4, 2005), available at http://www.alcei.org/?p=22, [It.] (requesting that the Italian Financial Police identify the authors of the XCP2 software used by Sony BMG Music Entertainment, forcing a criminal investigation into the matter in Italy).

[12]. DELTON T. HORN, DAT: THE COMPLETE GUIDE TO DIGITAL AUDIO TAPE 3 (1991).

[13]. MARK COLEMAN, PLAYBACK: FROM THE VICTROLA TO MP3, 100 YEARS OF MUSIC, MACHINES, AND MONEY 5 (2003) (tracing the history of music-industry recording and playback systems).

[14]. See White-Smith Music Publ'g Co. v. Apollo Co., 209 U.S. 1, 9 (1908) ("The record discloses that in the year 1902 ... from one million to one million and a half of such perforated musical rolls ... were made in this country in that year."). The player piano format, of providing codes representing which notes to play and the duration of each note, would later become the basis of the MIDI format, developed in the 1980s and still the modern code that allows communication between synthesizers and computers. Many computer applications that use MIDI call their editing window the "piano roll" view. See e.g., Mark of the Unicorn, Description of Performer Version 6 Macintosh sequencer software, available at http://thnlnk.com/motu/0000002802 (July 22, 2006 08:23 PDT) ("Performer is well known for its intuitive graphic interface ... [as well as its] graphic piano-roll-style editing ...").

[15]. See, e.g., FRANK MILNE, AN AMERICAN IN PARIS (1928) (piano roll) (composed by George Gershwin); FRANK MILNE, ALWAYS (1925) (piano roll) (composed by Irving Berlin).

[16]. See, e.g., MILNE, *supra* note 15.; *See also* COLEMAN, *supra* note 13 (citing Kennedy v. McTammany, 33 F. 584 (C.C. Mass. 1888) and Boosey v. Whight, (1899) 1 Ch. Div. 836).

[17]. White-Smith Music Publ'g Co. v. Apollo Co., 209 U.S. 1, 18 (1908).

[18]. See Ernst-Jo Volker & Sabine Fischer, Convention Paper 5060: Phillip Reis – From the First Telephone to the First Microphone, Address Before the Audio Engineering Society Convention (May 11, 2002).

[19]. *Id.*

[20]. *Id.*

[21]. *Id.*

[22]. See COLEMAN, *supra* note 13 at xix. Previously, audio technology allowed shifting the playback of audio through three dimensions – through space. The ability to record the audio allowed a shift in playback in four dimensions, adding the ability to play the material back in a different space and time.

[23]. Stern v. Rosey, 17 App. D.C. 562 (D.C. Cir. 1901) ("... the defendant inserted smooth wax cylinders in the said phonograph and, whilst they were being revolved therein under a metal horn or megaphone, caused the music to be played upon some musical instruments, and the words of the songs to be sung by some person. These were received and transmitted through the megaphone to what is called a sapphire recording point, having a sharp even surface, which engraved upon the revolving cylinders a record of both the music of the compositions and the words of the songs as received.").

[24]. Am. Graphophone Co. v. Universal Talking Mach. Mfg. Co., 145 F. 636, 637 (C.C.S.D.N.Y. 1906) ("[Edison's invention] ... consisted of cylindrical tablets having cut or engraved on their surfaces vertical undulations or irregularities of varying depth.").

[25]. Stern, 17 App. D.C. at 562.

[26]. *Id.* at 565-66 ("The precise question here presented for decision is a novel one because of the comparatively recent invention of the phonograph and the later extension of its uses as described in the bill, and there is no precedent directly in point to guide us.").

[27]. *Id.* at 566.

[28]. See, e.g., White-Smith Music Publ'g Co. v. Apollo Co., 209 U.S. 1, 9 (1908) (holding that the copying of pianola rolls did not constitute copyright infringement).

[29]. H. Henn, The Compulsory License Provisions of the U.S. Copyright Law, Report on the General Revision of the Copyright Law, Study No. 58 of S. Subcomm. on the Judiciary, 84th Congress 3 (Comm. Print 1956), reprinted in 1 G. Grossman, Omnibus Copyright Revision Legislative History ix (2001).

[30]. Act of Mar. 4, 1909, ch. 320, 41, 35 Stat. 1075, 1084 (formerly codified at 17 U.S.C. 27).

CHAPTER 1 --REGISTRATION OF COPYRIGHTS

§ 1. Exclusive rights as to copyrighted works

Any person entitled thereto, upon complying with the provisions of this title, shall have the exclusive right:

(a) To print, reprint, publish, copy, and vend the copyrighted work;

(b) To translate the copyrighted work into other languages or dialects, or make any other version thereof, if it be a literary work ...

(c) To deliver, authorize the delivery of, read, or present the copyrighted work in public for profit if it be a lecture, sermon, address or similar production, or other nondramatic literary work ...

(d) To perform or represent the copyrighted work publicly if it be a drama or, if it be a dramatic work and not reproduced in copies for sale, to vend any manuscript or any record whatsoever thereof ...

(e) To perform the copyrighted work publicly for profit if it be a musical composition; and for the purpose of public performance for profit, and for the purposes set forth in subsection (a) hereof, to make any arrangement or setting of it or of the melody of it in any system of notation or any form of record in which the thought of an author may be recorded and from which it may be read or reproduced: Provided, That the provisions of this title, so far as they secure copyright controlling the parts of instruments serving to reproduce mechanically the musical work, shall include only compositions published and copyrighted after July 1, 1909, and shall not include the works of a foreign author or composer unless the foreign state or nation of which such author or composer is a citizen or subject grants, either by treaty, convention, agreement, or law, to citizens of the United States similar rights ...

(f) To reproduce and distribute to the public by sale or other transfer of ownership, or by rental, lease, or lending, reproductions of the copyrighted work if it be a sound recording: Provided, That the exclusive right of the owner of a copyright in a sound recording to reproduce it is limited to the right to duplicate the sound recording in a tangible form that directly or indirectly recaptures the actual sounds fixed in the recording: Provided further, That this right does not extend to the making or duplication of another sound recording that is an independent fixation of other sounds, even though such sounds imitate or simulate those in the copyrighted sound recording; or to reproductions made by transmitting organizations exclusively for their own use.

See also Timothy Wu, Copyright's Communications Policy, 103 Mich. L. Rev. 278, 297-303 (2004) (tracing the impact of sheet music and piano roll manufacturers on the legislative process that led to Section 1(e) of the

Copyright Act of 1909).

[31]. See COLEMAN, *supra* note 13 at 6. The question of who invented the radio yields controversial answers because Marconi and Tesla were working on similar technologies at the same time. The resulting patents were in dispute for forty-four years. Regardless, the invention of the Tesla coil was an integral part of the development of radio technologies. PBS, Tesla – Master of Lightning: Who Invented Radio?, http://www.pbs.org/tesla/ll/ll_whoradio.html (last visited Jan. 17, 2007).

[32]. Tom Lewis, "A Godlike Presence": The Impact of Radio on the 1920s and 1930s, Org. of Am. Hist. Mag. of Hist., Spring, 1992, available at http:// www.oah.org/pubs/magazine/communication/lewis.html.

This rate of adoption would later be mirrored by other new developments. There were 136.4 million online paid downloads of singles through retailers such as the iTunes Music Store in 2004, growing to 366.9 million in 2005. 2005 Year End Statistics, Recording Industry Association of America, Manufacturers' Unit Shipments and Retail Dollar Value, http:// www.riaa.com/news/newsletter/pdf/2005yrEndStats.pdf (Mar. 29, 2006).

[33]. Tom Lewis, "A Godlike Presence": The Impact of Radio on the 1920s and 1930s, Org. of Am. Hist. Mag. of Hist., Spring, 1992, available at http:// www.oah.org/pubs/magazine/communication/lewis.html.

[34]. Carole E. Scott, History of the Radio Industry in the United States to 1940, EH.NET ENCYCLOPEDIA, Aug. 29, 2001, http:// eh.net/encyclopedia/article/scott.radio.industry.history (indicating that in 1913 there were 322 licensed amateur radio operators. By 1917 this number had grown to 13,581).

[35]. See, e.g., Buck v. Jewell-La Salle Realty Co., 283 U.S. 191, 195 (1931).

[36]. *Id.*

[37]. *Id.*

[38]. *Id.*

[39]. *Id.* at 202.

[40]. *Id.* at 200-201

[41]. Edison: The History of the Edison Cylinder Phonograph, http:// memory.loc.gov/ammem/edhtml/edcyldr.html (last visited July 25, 2006).

[42]. See, e.g., Neumann AM-131 Cutting Lathe, Audio, July 1965 at 15, available at http://www.firstcask.com/varsity/cutting.htm (advertising the Neumann AM-131 record cutting lathe from Gotham Audio Corporation with prices ranging from $4950 to $12,000).

[43]. See Act of Mar. 4, 1909, ch. 320, 41, 35 Stat. 1075, 1084 (formerly codified at 17 U.S.C. 27).

[44]. The Compact Cassette was invented by Philips and released in 1963. FRANCIS RUMSEY & TIM MCCORMICK, SOUND AND RECORDING: AN INTRODUCTION 167 (Focal Press 3rd ed. 1998) (1997).

[45]. Pearl Music Co. v. Recording Indus. Ass'n of Am., 460 F. Supp. 1060, 1061 (C.D. Cal. 1978) ("In 1969, plaintiff Martin began obtaining phonograph records manufactured by commercial record companies, duplicating the sounds recorded on those phonograph records onto cassette tapes, and supplying those duplicated cassettes to his customers.").

[46]. *Id.*; *See also* S. Rep. No. 104-128, at 10 (1995), as reprinted in 1995 U.S.C.C.A.N. 356, 357 (noting the advancements in duplication technology in the period preceding Congress's passage of the Sound Recordings Act of

1971).

[47]. S. Rep. No. 104-128, at 10 (1995), reprinted in 1995 U.S.C.C.A.N. 356, 357.

[48]. Pub. L. No. 92-140, 85 Stat. 391 (1971).

[49]. See S. Rep. No. 104-128, at 10 (1995), reprinted in 1995 U.S.C.C.A.N. 356, 357.

[50]. NEIL HELLER & THOMAS BENTZ, COMPACT DISC TROUBLESHOOTING & REPAIR 7 (1987).

[51]. See *Id.* ("Some losses occur in the head itself from internal currents ... Tape speed is a compromise between moving the tape quickly enough to provide space to record frequencies between 30 and 20,000 hertz and slow enough to provide a reasonable length of recording."); *See also Id.* at 12 ("In any form of an electromechanical device there will be some form of instability.").

[52]. See HORN, *supra* note 12 (detailing the deficiencies in analog tape recording).

[53]. See RUMSEY & MCCORMICK, *supra* note 44, at 169.

[54]. *Id.* at 367.

[55]. See HORN, *supra* note 12, at 371.

[56]. See RUMSEY & MCCORMICK, *supra* note 44, at 169.

[57]. See HORN, *supra* note 12 at 96-97.

[58]. *Id.*

[59]. See Henry Nyquist, Certain Topics in Telegraph Transmission Theory, 47 TRANSACTIONS OF THE AIEE 617, 617-44 (1928). This theory would later be proven correct by Claude E. Shannon in: Claude E. Shannon, Communication in the Presence of Noise, 37 PROCEEDINGS OF THE IRE 10, 10-21 (1939).

[60]. See Nyquist, *supra* note 59, at 617-44; *See also* Shannon, *supra* note 59, at 10-21.

[61]. The human ear is widely credited with a frequency response of 20Hz to 20kHz based on the research by Bell Labs in the 1920s. See, e.g., WILLIAM A. YOST, FUNDAMENTALS OF HEARING 152 (Academic Press 4th ed. 2000). Providing a digital sampling system that could replicate the entire frequency range of human hearing would require a system that could sample the audio stream at greater than 40kS/s (kilo(thousand)Samples/second). ROBERT A. KATZ, Mastering Audio 221 (Jim Johnston ed., Focal Press 2002) (2002) (explaining that frequencies above 20kHz are inaudible).

[62]. Kees A. Schouhamer Immink, The Compact Disc Story*, 46 J. Audio Eng. Soc., 458, 458 (1998), available at http://www.exp-math.uni-essen.de/~ immink/pdf/cdstory.pdf (detailing the events that led to the ability to digitally record audio. Referring to experiments conducted between 1969 and 1979 on optics and Laservisioin, "It is my view that digital audio was made possible at that point ....").

[63]. *Id.* at 459 ("In 1977-78 Philips and Sony both demonstrated the first prototypes of a digital sound system using a laser disk, and in 1979 a high-level decision was made to join forces in the development of a world standard.").

[64]. *Id.* at 460 (explaining that the chosen diameter was only .5cm larger than that of the diagonal dimension of a cassette tape).

[65]. *Id.* at 460-61.

[66]. See Nyquist, *supra* note 59; *See also* KATZ, *supra* note 61.

[67]. See RUMSEY & MCCORMICK, *supra* note 44 at 192.

[68]. While the human ear has a maximum dynamic range of around 120 decibels under laboratory conditions, the instantaneous dynamic range is much smaller. Once a person has been exposed to sound, the threshold of hearing adjusts as the physiology of the ear adapts. The dynamic range of the human ear thus "floats" up or down depending on the average level of the performance material. At any one time, however, the instantaneous dynamic range of the ear is significantly less than 120dB. See, YOST, *supra* note 61, at 256-59 (explaining the phenomenon of Temporary Threshold Shift); *See also*, YOST, *supra* note 61, at 152 (discussing the dynamic range capabilities of the ear).

[69]. *See generally* Decibel Sound Pressure Level Examples, http:// home.new.rr.com/trumpetb/audio/dBexamp.html (last visited Aug. 3, 2006) (showing that the typical ambient noise of listening environments is between 20dB SPL and 40dB SPL.). With music heard at a typical RMS of 85dB SPL, yielding peaks of nearly 100dB SPL, the dynamic range of most music in everyday listening environments is less than 90dB).

[70]. See KEN C. POHLMANN, PRINCIPLES OF DIGITAL AUDIO 246 (McGraw-Hill Professional 4th ed. 2000). A digital sampling system has no effect on the phase of a signal. The only variations of the signal are frequency attenuation above half the sampling frequency and dynamic range attenuation based on the bit depth of the conversion with a formula of roughly 6dB in dynamic range gained per bit of depth (the first bit is said to give more than 6dB of dynamic range, but this is a mistake since a linear 1-bit system cannot exist due to a shortage in the required amount of dither during the sampling process). See *infra* p. 45 and note 190.

[71]. However, the systems that play the CD were not perfect. While the format itself had capabilities wider than the ear's listening range, the early compact disc players were poorly implemented by modern standards. In recent years, these playback devices have finally started to match the capabilities of the format itself. See, e.g., POHLMANN, *supra* note 70, at 85-88.

[72]. See Schouhamer Immink, *supra* note 62 (showing the progression of audio storage ability: the wax cylinder was effectively capable of less than 100 bits/mm2 and the compact disc is capable of nearly 10 million bits/mm2).

[73]. Both the cassette tape and the phonograph endure change and wear from multiple plays. The cassette tape sheds magnetic fibers while the phonograph needle continues to scrape at the phonograph, both allowing for change to the media over time. See HELLER & BENTZ, *supra* note 50.

[74]. Steve Schoenherr, Recording Technology History, http:// history.sandiego.edu/gen/recording/notes.html (last updated July 6, 2005).

[75]. At the time of the development of the compact disc, manufacturing a CD was an all-inclusive process that started with raw materials and resulted in a finished product. Later, the technology for "burning" CDs developed such that the manufacturing of the CD itself is separate from the step of encoding information onto the blank disc.

[76]. See Schouhamer Immink, *supra* note 62 at 462.

[77]. DAVID MILES HUBER & ROBERT E. RUNSTEIN, MODERN RECORDING TECHNIQUES 439 (Focal Press 5th ed. 1997) (1995).

[78]. Edward LaMaster, Compact Disc Manufacturing Procedures and Processes, University of Washington (1994),

http:// www.ee.washington.edu/conselec/W94/edward/edward.htm (citing CHRIS SHERMAN, THE CDROM HANDBOOK 409 (1988) with reference to the expense of the equipment involved).

[79]. See *infra* note 102.

[80]. H.R. Rep. No. 102-873 (II), at 2 (1992).

[81]. *Id.* (referring to the recording industry's concern about the DAT recorder's ability to make “perfect,” multiple copies of recorded music). The difference between DAT machines and other devices at the time was that any other device sent the audio signal out in an analog format, and all analog transmission results in a degree of distortion. The DAT machines contained digital outputs and digital inputs, allowing consumers to transmit the signal digitally and without generation loss to subsequent machines for copying.

[82]. TASCAM DA-P1 OWNERS MANUAL 20 (TEAC), available at http:// www.tascamcontractor.com/ftp_resources/files/manual/DA-P1_manual.pdf (mentioning that DAT recorders were also capable of recording at 48kS/s.).

[83]. See HORN, *supra* note 12, at 97.

[84]. See H.R. Rep. No. 102-873 (II), at 2 (1992) (“… electronics industries and consumer rights organizations have argued that restricting the copy capability of DAT recorders would violate the consumer's “right” to reproduce copyrighted material for personal use under the fair use exceptions of the copyright law”).

[85]. *Id.*

[86]. *Id.*

[87]. *Id.*

[88]. *Id.*

[89]. Note that it took six years for Congress to complete a bill to appease the audio industry. During this time the industry threatened legal action against any and all distributors of DAT players or recorders. The first proposed industry-presented solution was in 1987. See *Id.*

[90]. Audio Home Recording Act of 1992, Pub. L. No. 102-563, 106 Stat. 4237.

[91]. *Id.* at 4240.

[92]. See, e.g., 138 Cong. Rec. H9029-01, H9046 (detailing the definition of SCMS in a proposed “Technical Reference Document” that was to accompany the Audio Home Recording Act.). Congress did not pass the Technical Reference Document, choosing instead to keep the definition of “Serial Copy Management System” relatively open. As implemented in the industry, however, SCMS conforms to IEC 60A(CO)130 part 1: Digital Audio Tape Cassette System (DAT) Dimensions and Characteristics and IEC 60A(CO)136 part 6: Serial copy management system for consumer audio use DAT recorders.

[93]. *Id.*

[94]. *Id.*

[95]. See Audio Home Recording Act of 1992, Pub. L. No. 102-563, 106 Stat. 4237, 4240-44.

[96]. See H.R. Rep. No. 102-873 (II), at 2 (1992) (noting that, as of 1991, DAT manufacturers had refrained from selling DAT machines since 1986).

[97]. See Schouhamer Immink (this author is not capitalized because the original cite does not capitalize the author), *supra* note 62, at 462.

[98]. JOHN JORDAN, TECHNOLOGY EVOLUTION AND THE MUSIC INDUSTRY'S BUSINESS MODEL CRISIS 2 (2003), available at http:// stillriverresearch.com/musicpaper.pdf (noting the repurchasing trend that boosted CD sales in the 1980s and 1990s, explaining the drop in the market in the 2000s).

[99]. DAT machines designed to be used in the professional audio and video industries for the production of audio and video content (classified as "professional model products") were exempt from the AHRA. These machines often contained the same machinery as those designed for home use, but with an option to defeat the SCMS protocol on the machine. See Audio Home Recording Act of 1992, Pub. L. No. 102-563, 106 Stat. 4237, 4238.

[100]. See HELLER & BENTZ, *supra* note 50 (indicating that all forms of analog transmission, and thus duplication, suffer generation loss).

[101]. See COLEMAN, *supra* note 13, at 172.

[102]. "Burning" compact discs actually requires a different technology than "pressing" (replicating) discs, which is used in commercial manufacturing plants. "Burning" involves putting the pits and lands on the disc by burning holes in a layer of substrate with a laser. In a "pressed" disc the pits and lands are molded into the disc. See Sweetwater inSync, http:// www.sweetwater.com/insync/word/cdr (last visited July 25, 2006) (clarifying the difference between homemade and factory-manufactured CDs).

[103]. Prepared Statement of Thomas C. Tyrrell Senior Vice President General Counsel and Secretary Sony Music Entertainment Inc.: Hearing Before the H. Comm. on Int'l Relations, Subcomm. on Int'l Econ. & Trade, 106th Cong. (2000) (explaining industry concerns about the common practice in the United States of users sharing their purchased music through the internet).

[104]. U.N. CONFERENCE ON TRADE AND DEVELOPMENT [UNCTAD], E-COMMERCE AND DEVELOPMENT REPORT 2004, at 72, UNCTAD/SDTE/ECB/2004/1 (2004) (describing the flexibility consumers acquire once music is in digital file format).

[105]. See POHLMANN, *supra* note 70, at 358-62 (describing listening tests for perceptual coding algorithms).

[106]. *Id.*

[107]. *Id.*

[108]. Both MP3 and AAC have options that allow users to select different choices for the compression scheme. *See generally* Fraunhofer IIS, Audio and Multimedia Realtime Systems, http://www.iis.fraunhofer.de/amm/projects/mp3 (last visited July 26, 2006).

[109]. Karlheinz Brandenburg, MP3 and AAC Explained 2 (Fraunhofer Institute for Integrated Circuits FhG-IIS A (1999) (written for the 17th AES International Conference on High Quality Audio Coding).

[110]. The Apple Power Macintosh 7500 computer released in 1995 came with either a 500MB or 1GB hard disk. The base price was $3000. EveryMac.com, Power Mac 7500/100 Specs, http:// www.everymac.com/systems/apple/powermac/stats/powermac_7500_100.html (last visited Jan. 17, 2007).

[111]. Kenneth Lee & Woong-kyo Suh, Realtime Audio On the Internet, Bandwidth Limitations,

http://www.seas.upenn.edu/~ ksl/Classes/TCOM500/InternetAudio/index.html (last revised Dec. 9, 1996) (discussing the need for data compression of audio files over the internet).

[112]. Recording Indus. Ass'n of Am. v. Diamond Multimedia Sys., 180 F.3d 1072, 1078 (9th Cir. 1999).

[113]. *Id.*

[114]. *Id.*

[115]. *See generally* Schouhamer Immink, *supra* note 62.

[116]. See POHLMANN, *supra* note 70, at 249-52.

[117]. See POHLMANN, *supra* note 70, at 250. The header bits, identified as P, Q, R, S, T, U, V, and W, are used for various purposes. The P&Q subcode bits are used for table of contents and track identification.

[118]. See 138 Cong. Rec. H9029-01, H9046.

[119]. This provides roughly 2.4MB of unused data on the disc. However it is spread evenly across the disc rather than a single "chunk" of available disc space. Some have suggested using the R&W subcodes (1/3 of the available unused data) for track labeling and lyrics. The HDCD format used all of the available, unused subcodes to add more data to the recording to improve the sound quality. *See generally* P OHLMANN, *supra* note 70, at 172-78.

[120]. *See generally* Sony BMG Music Entertainment, BMG Company Statement on Copy Control, http://www.bmgcopycontrol.com/uk-ireland (last visited July 27, 2006) (explaining Sony BMG's position on and use of Copy Control as well as providing information to consumers about how to know when Copy Control is in use).

[121]. John A. Halderman, Evaluating New Copy-Prevention Techniques for Audio CDs 5-9, available at http://www.cs.princeton.edu/~ jhalderm/papers/drm2002.pdf (last visited July 27, 2006) (explaining the results of a study at the Princeton University Computer Science Department to ascertain how the Copy Control techniques work).

[122]. Reuters, CD creator burns copy-protection efforts (Jan. 17, 2002), available at http://www.ukcdr.org/issues/cd/links/news.com.com_2100-1023-817937.html (reporting that Philips, the trademark holder of the CD-DA logo, warned the five major record labels that discs with digital rights management such as Copy Control did not meet the red book CD-DA protocol and would not be allowed to use the CD-DA logo).

[123]. See Sony BMG, *supra* note 120 (showing a graphical representation of which devices show incompatibility with Copy Control discs).

[124]. Tribunal de Grande Instance [T.G.I.] [ordinary court of original jurisdiction] de Nanterre, Sept. 2, 2003, No. R.G. 03/06625 (Fr.), available at http://www.legalis.net/jurisprudence-decision.php3?id_article=34.

[125]. *Id.*

[126]. Press Release, Key2Audio, Key2audioXS offers innovative copy control and marketing solutions (July 22, 2003), available at http:// www.key2audio.com/news.asp?id=1 ("… key2audio worked by preventing playback of protected discs on computer drives …").

[127]. Digital Property Protection, Hearing Before the S. Comm. on the Judiciary, 107th Cong. (2004) (testimony of Richard Parsons, CEO Designate AOL Time Warner) (explaining the use of watermarks in digital media such as music).

[128]. See Catherine Applefeld Olson, Audio Magic's Capabilities May Charm the Industry, BILLBOARD,, January 11, 2003, available at http:// www.audiblemagic.com/news/articles/art-2003-01-11-Billboard.pdf (discussing a company that is providing the music industry with watermarking tools to track the flow of music copies); *See also*, Press Release, Thomson, Thomson Provides Studios Assistance with Security Services On VHS and DVD Screeners For 2003 ACADEMY AWARD Season (Feb. 16, 2004), available at http:// www.thomson.net/EN/Home/Press/PressReleases/CorporatePress/PREN040216.htm (announcing the use of watermarking on DVDs distributed to Academy members to preview movies for the Academy Awards in order to track copies of those movies that make their way into the public sector).

[129]. *Id.*

[130]. See Senate Hearing on Digital Property Protection, *supra* note 127 (explaining the need for government regulations to ensure enforcement of the watermark as an effective tool to curb digital piracy).

[131]. Richard Elen, DVD-Audio Watermarking Fiasco Continues (AudioRevolution.com August 9, 2000), http:// www.avrev.com/news/0800/09.dvdwatermark.shtml (explaining the result of a test of recording engineers who were able to audibly identify the watermark used by SDMI (see *infra* note 126)).

[132]. See, e.g., *Id.*

[133]. *See generally* Secure Digital Music Initiative (SDMI) Frequently Asked Questions, http://www.sdmi.org/FAQ.htm (last visited June 27, 2006) (explaining how the SDMI digital watermarking system was intended to operate with music downloads and portable listening device playback authorization).

[134]. *See generally* John A. Felderman, Analysis of the MediaMax CD3 Copy-Prevention System (Princeton University Computer Science Department, Technical Report TR-679-03), available at http:// www.cs.princeton.edu/research/techreps/TR-679-03 (explaining that the MediaMax software runs by means of running an automatic application that puts digital rights management on the consumer's computer).

[135]. Press Release, BMG and SunnComm Technologies Ink Worldwide Licensing Deal to Protect and Enhance Audio CDs for Global Music Giant (June 30, 2003), available at http://www.sunncomm.com/press/pressrelease.asp?prid=200306300915.

[136]. Posting of Mark Russinovich to Mark's Blog, Sony BMG Music Entertainment: End User License Agreement (Jan. 7, 2005), http:// www.sysinternals.com/blog/sony-eula.htm.

[137]. See *supra* Part I.

[138]. Gordon Moore, Cramming More Components onto Integrated Circuits, ELECTRONICS M AG., April 19, 1965 (“The complexity for minimum component costs has increased at a rate of roughly a factor of two per year.”).

[139]. See, e.g., *supra* Part II.4.B (regarding the emergence of the DAT tape in 1986 to provide longer recording times, consumer recordability, and more data storage ability).

[140]. See COLEMAN, *supra* note 13, at 171 (alleging that “the seeds of disenchantment were sprouting among music consumers.”).

[141]. Joel Brinkley, After 15 Years, the Music CD Faces an Upscale Competitor, N.Y. TIMES, July 28, 1997, at A1 (explaining that one of the supposed purposes of the DVD-Audio format was to respond to complaints from audiophiles who objected to the sound quality of the compact disc format).

[142]. See POHLMANN, *supra* note 70, at 85-88 (explaining the conversion methodology used in early CD players

and detailing the many changes that would be made to these conversion systems over the ensuing decades).

[143]. See POHLMANN, *supra* note 70, at 85-88.

[144]. Converters are inherently capable of representing the entire bandwidth from 0Hz to the Nyquist Frequency, or half of the sample frequency. On CD players this would be equivalent to the frequency range extending from 0Hz to 22.05kHz, or half of the 44.1kS/s sample rate. *See generally* NIKA ALDRICH, DIGITAL AUDIO EXPLAINED – FOR THE AUDIO ENGINEER 140-63 (2d ed. 2005).

[145]. See POHLMANN, *supra* note 70, at 93.

[146]. E-mail from Richard Kulavik, Manager of Marketing and Applications Engineering at AKM Semiconductor (July 31, 2006, 14:45:20 PDT) (on file with author) (responding to an inquiry about the frequency response of early digital to analog converters used in CD players, "In the early stages of these designs they did not use any digital filters … many of these did destroy audio above 10K [kHz]. It was not until about 1990 that the bandwidth was really 20-20K without a problem.").

In digital to audio converters used in early CD players, the filtering was done with analog components as opposed to digital technology. Analog filters inherently yield a relationship between the "steepness" of the filter (measured in poles) and the amount of phase-shift they impart on the signal, such that the steeper the filter the more phase shift. Early converters tried to strike a balance between the affected range and the amount of phase shift of the audio, providing a filter that did not affect more than the top octave of the human's audible range but at the consequence of phase shifting of the audio within the human audible range.

[147]. See KATZ, *supra* note 61, at 222 (explaining the advantages of oversampling in both analog to digital and digital to analog converters).

[148]. See POHLMANN, *supra* note 70, at 102 (overviewing the stability and adaptability of digital filters used in oversampling converters).

[149]. *See generally* POHLMANN, *supra* note 70, at 246 (explaining that in the year 2000 (the date of publishing), audio CD players are capable of a frequency response beyond that of the human ear and over 100dB of dynamic range and signal-to-noise ratio and shifts of less than half a degree which make the player itself inaudible in the CD playback).

[150]. See Press Release, Digidesign, Digidesign Announces Brand-New, High Definition Pro Tools|HD Systems at Winter NAMM 2002 (Jan. 18, 2002), available at http://phx.corporate-ir.net/phoenix.zhtml?c=82844&p=irol-newsArticle&ID=248254&highlight= (announcing the release of 96kS/s compatible computer editing system from Digidesign, the largest manufacturer of computer-based audio editing systems in the recording industry).

[151]. E-mail from Paul Frindle, Previous Director of Sony's Oxford Division (Aug. 1, 2006, 02:02:56 GMT) (on file with author) (responding to query about the dynamic range of early CD players: "Around 70 – 75dB for the best of the early ones ... [which are] limited by bad converters and analogue filters. But [they are] still significantly better than even a high end record player.").

[152]. *Id.* (responding to query about the dynamic range of phonographs: "The records that we typically bought and played at home did around 50 – 55dB because of manufacturing pressing flaws and mechanical noise in the players. But a really good pressing of a well cut master, played back on a superb system (or the cutting lathe itself) could do as much as 70dB to 75dB ... Significantly better than analogue tape in both SNR [Signal to Noise Ratio] and phase/impulse response.").

[153]. Typical signal-to-noise ratios for analog devices range from 60 to 70 decibels. See HELLER & THOMAS BENTZ, *supra* note 50, at 18 ("The range of signal levels that can be handled by digital signals is much greater than that of analog, which can become noisy and saturate at high signal amplitudes.").

[154]. *See generally* POHLMANN, *supra* note 70, at 643-46 (explaining the background and development of the delta sigma modulator and its use in audio applications).

[155]. See POHLMANN, *supra* note 70, at 646-47.

[156]. Press Release, Digidesign, Digidesign Introduces 888/24 I/O Converter for Pro Tools 24 (Sept. 26, 1997)(announcing the release of a twenty-four bit audio interface for the ubiquitous Pro Tools recording software/hardware system).

[157]. See, e.g., Apogee Electronics, AD-8000 Operating Manual and UV-22 User License Agreement (Rev. 1.4) at 32 (1998) (providing a specification of the AD-8000 A/D converter with 114dB of dynamic range).

Excess dynamic range is needed on the recording side for multiple reasons: it provides needed headroom to prevent "clipping" or exceeding the maximum range during the recording, it gives extra bandwidth necessary to properly processing the signal, and it accounts for the fact that music during recording has not been "mastered" to take full advantage of the available dynamic range.

[158]. See YOST, *supra* note 61.

[159]. See POHLMANN, *supra* note 70, at 363 (describing the quest for larger storage devices for delivery formats as early as 1994).

[160]. M. N. Harris, R. Kelly, D. A. McLeod, & M. J. Story, Effects in High Sample Rate Audio Material at 1, (dCS Ltd. 1998) (presented at 20th Tonmeistertagung, Karlsruhe, Germany), available at http:// www.dcsltd.co.uk/technical_papers/effects.pdf (citing the increased demand for high sample rate recording ability amongst recording engineers in 1998).

[161]. In terms of raw data, excluding header or table of contents data, 44.1kS/s – sixteen bit recording requires approximately 10MB per minute for stereo recording. 96kS/s – twenty-four bit recording requires approximately 35 MB per minute for stereo recording.

[162]. See HUBER & RUNSTEIN, *supra* note 77, at 445 (explaining that DVDs can store a maximum of 17GB).

[163]. See POHLMANN, *supra* note 70, at 389 (describing the history of the DVD-Audio format); *See also* Press Release, Dolby Laboratories, Inc., DVD-Audio Demonstrated at AES 2003 (March 22, 2003).

[164]. See POHLMANN, *supra* note 70, at 389.

[165]. See POHLMANN, *supra* note 70, at 389.

[166]. See POHLMANN, *supra* note 70, at 389. Sample rates up to 96kS/s can be used for surround material. Due to bandwidth limitations, material recorded at 176.4kS/s or 192kS/s is limited to stereo reproduction only. See POHLMANN, *supra* note 70, at 390-93 (detailing the format of DVD-Audio).

[167]. See POHLMANN, *supra* note 70, at 389. 5.1 included five full range speakers plus the Low Frequency Effects (LFE) channel reserved for the subwoofer.

[168]. See POHLMANN, *supra* note 70, at 389.

[169]. See JORDAN, *supra* note 98.

[170]. In 1996, an International Steering Committee (ISC), consisting of the IFPI, RIAA and the RIAJ along with

the major international music companies, produced a set of recommendations for a follow-up format to the CD. This eventually became the DVD-Audio format. Among these recommendations were copy protection and anti-piracy measures. GRAHAM SHARPLESS, NEW FORMATS FOR MUSIC: DVD AND SACD 4 (2003), available at http://www.discusa.com/downloads/tech_ docs/DVD-Audio.pdf.

[171]. See POHLMANN, *supra* note 70, at 397.

[172]. Richard Elen, DVD Forum Issues Guidelines for DVD Digital Interfacing, AudioRevolution.com, Jan. 1, 2002, available at http:// www.ambisonic.net/dvd1394.html.

[173]. See HORN, *supra* note 12, at 96-97.

[174]. Announcements of 4C Entity LLC, http://www.4centity.com (last visited Feb. 9, 2005) (discussing updates to the licensing agreement for DVD-Audio hardware manufacturers).

[175]. Digital watermarking does not provide a form of copy protection but rather allows authors to add a "watermark" to discs that can aid in tracing the source of copies brought to market. See *supra* Part II.4.C.

[176]. See POHLMANN, *supra* note 70, at 397-98 (describing the copy-protection methods used in DVD-Audio format).

[177]. See POHLMANN, *supra* note 70, at 397-98.

[178]. See POHLMANN, *supra* note 70, at 295 (explaining the history and format of the SACD format).

[179]. See POHLMANN, *supra* note 70, at 297.

[180]. See POHLMANN, *supra* note 70, at 296.

[181]. See JORDAN, *supra* note 98.

[182]. See POHLMANN, *supra* note 70, at 297.

[183]. See SHARPLESS, *supra* note 170, at 8.

[184]. See POHLMANN, *supra* note 70, at 300-301 (describing the design of the outputs of an SACD player).

[185]. Jon Iverson, Firewire SACD and DVD-Audio, STEREOPHILE, Jan. 5, 2003, available at http://www.stereophile.com/news/11536/ (conveying an announcement from Texas Instruments that it has released a new interface protocol for conveying both DVD-Audio and SACD information through a digital medium to connect digital audio players to their respective processors).

[186]. Anthony Tommasini, Classical Recording: Spinning Into Oblivion, N.Y. TIMES, Oct. 21, 2001, at 21.

[187]. Ken Belson, Technology; Video Marches On, Without a Standard, N.Y. TIMES, June 20, 2005, at C6 (quoting Jupiter Research director, Michael Gartenberg, who said that consumers generally wait for the uncertainty inherent in format wars to resolve before buying into new formats).

[188]. See POHLMANN, *supra* note 70, at 246.

[189]. See, e.g., POHLMANN, *supra* note 70, at 446-55 (detailing the multiple options for encoding of any DVD-Audio disc, including multiple sample rates, bit depths, speaker configurations, video, graphics, and other features).

[190]. See, e.g., Stanley P. Lipshitz & John Vanderkooy, Why 1-Bit Sigma-Delta Conversion is Unsuitable for High-Quality Applications, Audio Eng. Soc. Convention Paper 5395 (2001); Stanley P. Lipshitz & John Vanderkooy, Towards a Better Understanding of 1-Bit Sigma-Delta Modulators, Audio Eng. Soc. Convention Paper 5620 (2002) (alleging that sigma-delta modulation has inherent idle-tone problems that make it an inferior format for audio storage in comparison to multi-bit systems).

[191]. 20% of Americans now own a portable listening device, indicating the quantity of listening with headphones, often while exercising, transporting, or otherwise being mobile as opposed to a sedentary listening environment. Press Release, Ipsos, Portable MP3 Player Ownership Remains High (June 29, 2006) (on file with author).

[192]. See POHLMANN, *supra* note 70, at 246 (explaining the specifications of modern CD players).

[193]. See RIAA 2005 Year-End Statistics, Recording Industry Association of America, http://www.riaa.com/news/newsletter/pdf/2005yrEndStats.pdf (showing that sales of DVD-A and SACD albums combined have never exceeded .2% of market share, which is below that of even phonograph sales).

[194]. See E-COMMERCE AND DEVELOPMENT REPORT 2004, *supra* note 104, at 80.

[195]. See COLEMAN, *supra* note 13, at 206.

[196]. See BMG Company Statement on Copy Control, *supra* note 120 (showing that the total revenue for downloads of songs averaged $.99 per song and $9.90 per album, whereas the revenue for CDs indicates an average price of $14.91 per album).

[197]. Press Release, Apple Computer Co., iTunes Music Store Catalog Tops One Million Songs (Aug. 10, 2004), available at http:// www.apple.com/pr/library/2004/aug/10itms.html.

[198]. Press Release, Apple Computer Inc., Apple Introduces New iPods (Apr. 28, 2003) (announcing new iPods available the same day as the announcement of the iTunes Music Store).

[199]. Press Release, Apple Computer Inc., Apple Unveils AirPort Express for Mac & PC Users (June 7, 2004).

[200]. Apple's iTunes Music Store Customer Service, http:// www.apple.com/lu/support/itunes/authorization.html (last visited July 31, 2006).

[201]. France Softens iTunes Law, But Apple Is Still Disgruntled, N.Y. TIMES, June 23, 2006, at C2.

[202]. WIPO Performances and Phonograms Treaty, adopted on May 20, 2002, 36 I.L.M. 76.

[203]. WIPO Copyright Treaty, adopted on Mar. 6, 2002, 36 I.L.M. 65.

[204]. 17 U.S.C. § 101.

[205]. Universal City Studios, Inc. v. Reimerdes, 82 F. Supp. 2d 211, 221 (S.D.N.Y. 2000) (noting that the DMCA was passed to address technological issues).

[206]. 17 U.S.C. § 512.

[207]. 17 U.S.C. §§ 1201-04.

[208]. 17 U.S.C. § 1201 (a)(1)(A) & (a)(2) (“No person shall circumvent a technological measure that effectively

controls access to a work protected under this title." Also "No person shall manufacture, import, offer to the public, provide, or otherwise traffic in any technology, product, service, device, component, or part thereof, that … is primarily designed or produced for the purpose of circumventing a technological measure that effectively controls access to a work protected under this title …").

[209]. 17 U.S.C. § 1201 (3).

[210]. 17 U.S.C. § 1201a.

[211]. 17 U.S.C. § 1201 (2).

[212]. 17 U.S.C. § 1201 (3).

[213]. See *supra* Part II.4.B.

[214]. 17 U.S.C. § 1201 (3) (B).

[215]. See *supra* Part II.4.D.

[216]. This topic would be an intriguing source for further exploration. Would an encryption scheme designed to prevent playback of a digital file except as authorized fall into the category of access control or copy control? A court could see this type of technological protection measure as preventing copies by means of encrypting the copies so that they would be unusable. As such, circumventing the copy might be a violation of both the copy control and access control provisions of the DMCA. On the other hand, a court could find that encryption is not copy control as it "allows the copy but prevents the copy's access." In either case, at this time the encrypted files would be protected by the access control protection measure of the DMCA (which is the more restrictive of the provisions) by preventing the mere use of such technological protection as opposed to only preventing the manufacture or trafficking in such measures. Finally, a court could find that encryption when used as a copy control no longer functions as access control. A court could analogize the Court's reasoning in White-Smith Music Pub'g Co. v. Apollo Co., 209 U.S. 1, 9 (1908), in which the court found that the copy, being unrecognizable as music in any conventional system, was not a copy. In this vein, the copy of the file may not be considered a "copy" as it is encrypted and inaccessible by any relevant means of observation. Thus, circumvention of the encryption might mean circumventing a copy control measure but not a circumvention of access control which would be a less desirable approach for copyright holders.

[217]. See *supra* Part II.4.E.

[218]. Stuart M. Robinson, DVD-Audio News: DVD-Audio Copy Protection Defeated via WinDVD Software Hack, http:// www.highfidelityreview.com/news/news.asp?newsnumber=14550899 (last visited Aug. 3, 2006).

[219]. *Id.*

[220]. Eric Dahl, The Playlist: Digital Music Heads to the Courts, PC WORLD, Apr. 22, 2005 (reporting that two hackers had circumvented Apple's Fairplay software to allow users to remove digital rights management software from iTunes downloaded files).

[221]. Bill Rosenblatt, iTunes DRM Hacked, Then Hacked Again, DRM WATCH, http://www.drmwatch.com/drmtech/article.php/3492676 (Mar. 24, 2005).

[222]. Posting of Mike D. to Mad Dog in the Fog Blog: iTunes Song Purchases plotted on a graph, http://maddogfog.blogspot.com/2006/02/itunes-song-purchases-plotted-on-graph.html (Feb. 26, 2006) (plotting the sales of songs at the iTunes Music Store and showing a still-increasing trajectory of said sales).

[223]. See Reuters, *supra* note 122.

[224]. See RIAA 2005 Year-End Statistics, *supra* note 193.

[225]. See RIAA 2005 Year-End Statistics, *supra* note 193 (statistics from singles added at 1/10th the value of album sales).

[226]. See RIAA 2005 Year-End Statistics, *supra* note 193; *See also* accompanying text (complete album downloads for 2005 were 13.6 million, individual song downloads were 366.9 million).

[227]. See RIAA 2005 Year-End Statistics, *supra* note 193.

[228]. See RIAA 2005 Year-End Statistics, *supra* note 193.

[229]. See *supra* Part I.

[230]. See *supra* Part II.4.C.

[231]. U.N. CONFERENCE ON TRADE AND DEVELOPMENT [UNCTAD], THE DIGITAL DIVIDE: ICT DEVELOPMENT INDICES 2004 13-14, UNCTAD/ITE/IPC/2005/4 (2004).

[232]. *Id.*

[233]. See E-COMMERCE AND DEVELOPMENT REPORT 2004, *supra* note 104, at 64.

[234]. See E-COMMERCE AND DEVELOPMENT REPORT 2004, *supra* note 104, at 64.

[235]. See E-COMMERCE AND DEVELOPMENT REPORT 2004, *supra* note 104, at 64 (showing that in 2003 the global market purchased 466 million cassettes and 2.13 billion CDs).

[236]. Press Release, IFPI, World Sales 2005 – The Key Facts and Figures, available at http://www.ifpi.org/sitecontent/press/20060331b.html (last visited July 26, 2005).

[237]. National Science Foundation, Science and Engineering Indicators 2006, Chapter 6: Industry, Technology, and the Global Marketplace – U.S. Royalties and Fees Generated from Intellectual Property, http://www.nsf.gov/statistics/seind06/c6/c6s3.htm (last visited Aug. 3, 2006).

[238]. *Id.*

[239]. Stephen E. Siwek, ENGINES OF GROWTH: ECONOMIC CONTRIBUTIONS OF THE US INTELLECTUAL PROPERTY INDUSTRIES 1 (2005), available at http://www.nbcumv.com/corporate/Engines_of_Growth.pdf.

[240]. *Id.* at 49.

[241]. *Id.* at 46.

[242]. See, e.g., *Id.* at 45.

[243]. David E. Sanger, Summit in New York: The Overview; Clinton Warns U.N. of a New Age of Civil Wars, N.Y. TIMES, Sept. 7, 2000, at 20A.

[244]. G.A. Res. 55/2, U.N. Doc. A/55/L.2 (Sept. 18, 2000).

[245]. *Id.* at ¶ III.

[246]. U.N. Conference on Trade and Development, June 13-18, 2004, High-Level Panel on Creative Industries, ¶ 3, U.N. Doc TD/L.379 (June 16, 2004).

[247]. "Rockin' All Over the World": Economic Potential of Music for LDCs, U.N. Doc LDCIII/Press/02 (May 16, 2001).

[248]. See E-COMMERCE AND DEVELOPMENT REPORT 2004, *supra* note 104, at 66, 89 (explaining that countries with large diaspora markets abroad will sell more music internationally).

[249]. See, e.g., U.N. Conf. on Trade and Development [UNCTAD], Electronic Commerce and Music Business Development in Jamaica: a Portal to the New Economy?, 22, U.N. Doc. UNCTAD/ITE/TEB/8 (2002) (prepared by Zeljka Kozul-Wright).

[250]. See E-COMMERCE AND DEVELOPMENT REPORT 2004, *supra* note 104, at 89.

[251]. See E-COMMERCE AND DEVELOPMENT REPORT 2004, *supra* note 104, at 65-66.

[252]. IFPI, The Recording Industry 2005 Commercial Piracy Report 9 (2005), available at http://www.ifpi.org/sitecontent/library/piracy2005.pdf.

[253]. Peter Burrows & Ron Grover, Apple's iTunes movie muddle, MSNBC, http://www.msnbc.msn.com/id/13463631 (June 21, 2006).

[254]. *Id.*

[255]. Chris Taylor, Invasion of the Movie Snatchers. More and More Movie Fans are Sharing Films Online, and Hollywood Doesn't Like it. Should the Studios Fight or Find a Way to Adapt?, TIME, October 11, 2004, at A2.

[256]. *Id.*

[257]. DVD Copy Control Association Frequently Asked Questions, http:// www.dvdcca.org/faq.html (last visited Aug. 3, 2006).

[258]. See Taylor, *supra* note 255.

[259]. Justin D. Fitzdam, Private Enforcement of the Digital Millennium Copyright Act: Effective Without Government Intervention, 90 Cornell L. Rev. 1085, 1091-93 (documenting the case of Dmitry Sklyarov, the Russian cryptologist who gave a presentation at the DEF CON convention in Las Vegas in 2001 regarding research done for his Ph.D. on the encryption methods used in Adobe System Inc. eBooks software).

[260]. Fred Koenigsberg, Patents, Understanding Basic Copyright Law 2006, 871 Prac. L. Inst. 49.

[261]. The "first sale doctrine" has been codified to some extent in 17 U.S.C. § 109. A separate right for the copying of computer software can be found in 17 U.S.C. § 117.

[262]. 17 U.S.C. § 107.

[263]. Computers in use per 1000 people in the US went from 13.4 in 1980 to 808 in 2005. eTForecasts –

Executive Summary, Computers-in-Use 5, http://www.etforecasts.com/products/ES_cinusev2.htm (last visited July 26, 2006).

[264]. This philosophy is generally ascribed to John Locke. *See generally* Locke, TWO TREATISES ON GOVERNMENT, Bk II sec 135-37 (explaining that the role of the government is preservation of the rights of the people).

[265]. U.S. Const. art. I, § 8, cl. 8 (Congress shall have the power "to promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries.").

[266]. Recording Indus. Ass'n of Am. v. Diamond Multimedia Sys., 180 F.3d 1072, 1078 (9th Cir. 1999).

[267]. Pew Internet & American Life Project, Pew Internet – Music and Video Downloading, http://www.pewinternet.org/PPF/r/153/report_display.asp (Mar. 23, 2005) (reporting the results of a study that indicated that 27% of Americans download music and video content, and half of these have done it outside of either peer-2-peer or legal, paid download sites).

[268]. 17 U.S.C. §§ 1203-1204.

[269]. Since the R, S, T, U, V, and W subcodes are not in use in compact discs, a SCMS approach could use a six-bit code instead of the two-bit code used on DAT. Utilizing all six bits could provide as many as sixty-four levels of protection, including possibly allowing individual control to the copyright holder regarding how many portable devices the material could be shared with, whether or not the material could be shared with a secondary computer, and whether or not the file could be burned onto another disc. Compliant computers would contain software that regulated the use of said files. Files could even be locally encrypted and watermarked once inside the computer with a scheme much like Apple's Fairplay, treating individual computers as the decrypting servers regulated by the SCMS code on the CD because the CD itself would still be red book compliant.

[270]. 17 U.S.C. § 1204.

[271]. The SCMS protocol on DAT tapes involved merely setting two bits in the subcode of the file. This specification for the DAT format was publicly documented in industry literature and even in open debate in the United States Congress. It would be remarkably easy to create a program that would circumvent this technological protection by changing the status of the subcode bits in the file.

[272]. See Dahl, *supra* note 220.

[273]. See Mad Dog in the Fog Blog, *supra* note 222.

