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# Effectiveness of anti-piracy technology: Finding appropriate solutions for evolving online piracy

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## KEYWORDS

Piracy;  
P2P;  
Consumer complicity;  
Supply chain ecosystem;  
Digital rights management (DRM)

**Abstract** Trends in online piracy have reached record levels and threaten traditional industry supply chains. Music, motion pictures, print media, and software are some of the most vulnerable content pirated online. Recent increases in piracy can be historically traced to the digital revolution, introduction of the World Wide Web, and growth of broadband technologies, rather than a sudden shift in consumer behavior. The digital and Internet paradigm shifts have fundamentally changed supply chain ecosystems, as well as opened the door to greater acts of piracy. Under these new ecosystems, digital rights management (DRM) has proven ineffective at stopping piracy. Furthermore, DRM systems have been shown to discourage legitimate buyers. A new approach to piracy is needed to account for recent changes in supply chain ecosystems. Several industry leaders demonstrate effective solutions combining technology and innovative business models that encourage consumers toward legitimate consumption while leveraging piracy. Given these examples, industries can address online piracy by combining appropriate technology, innovative business models, and piracy analytics in the evolving supply chain ecosystems.

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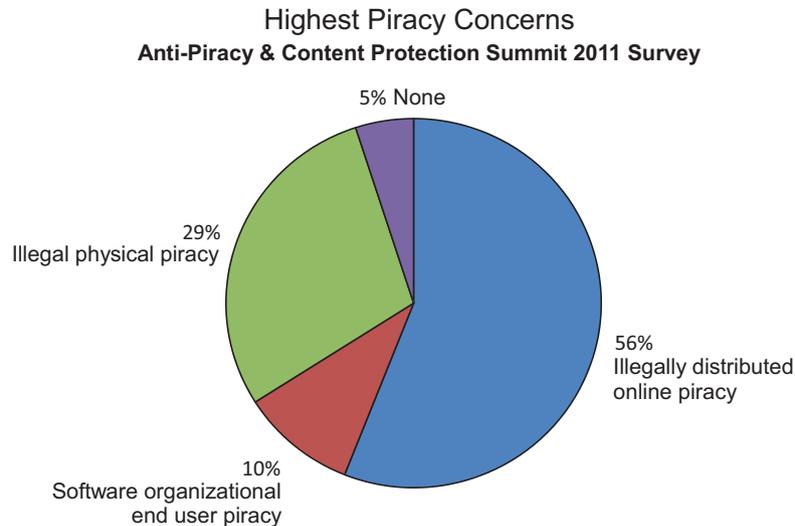
## 1. A perfect storm stemming from the digital revolution

Online piracy poses a unique problem for content manufacturers. Pure information assets produced by the music, motion picture, print media, and software industries are considered some of the most vulnerable to online piracy. These industries face challenges countering deliberate acts of piracy by

peer-to-peer (P2P) sharing communities, Warez groups, and organized crime. On the flip side, industries must contend with complicit consumers who perceive piracy as no big deal. Today, piracy accounts for 42% of all online transactions (Wikipedia, 2012). Although rates of online piracy in the United States (21%) are considered relatively low by global standards, other regions average as high as 88% (Wikipedia, 2012). According to a 2011 Anti-Piracy & Content Protection Summit survey, over 50% of respondents expressed concern regarding online piracy (see Figure 1).

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Figure 1. Measure of highest piracy concerns



Source: *Anti-Piracy & Content Protection Summit 2011 survey results*. Retrieved from <http://www.antipiracycontentsummit.com>

The digital revolution has been one of the major factors responsible for these trends. The primary advantage of storing information digitally is that it allows content owners to copy, keep, and transmit large volumes of information as originally formatted (Larabi, Rosselli, & Fernandez-Maloigne, 2009). Since the arrival of the digital revolution, content has become easier to copy with little to no loss in quality. Another influential factor has been the introduction of the World Wide Web, a commercial Internet protocol that has essentially opened the front door to low cost global distribution. A third catalyst has been the rapid increase of high speed networks. Advances in broadband technology have allowed people to upload and download large files quickly. The presence of these three factors has become a 'perfect storm' for online piracy—a condition that if not managed appropriately could significantly damage market growth and industry sustainability.

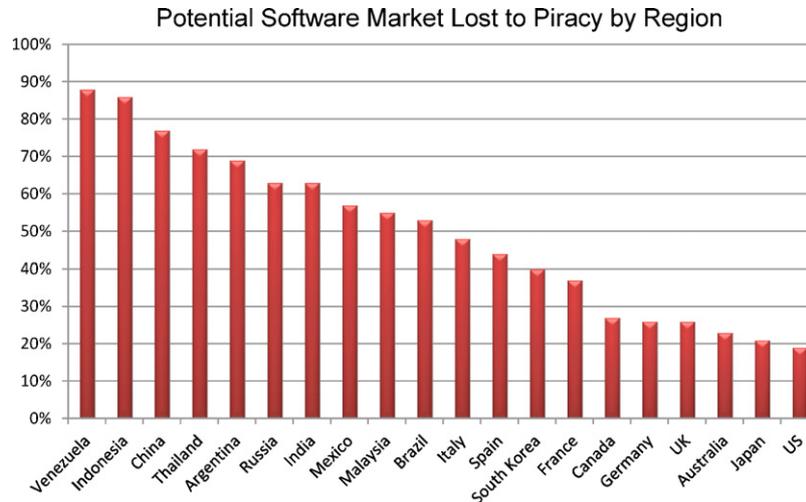
The music industry, for instance, has been one of the most impacted by online piracy. Music enthusiasts can download music from peer-to-peer sites or access unauthorized music posted on sharing sites such as YouTube. Despite some advancements made toward legitimacy, China's largest search engine site, Baidu, continues to operate a highly popular music sharing service (Young, 2011). An estimated 10 million consumers download pirated music files from the Internet, with nearly half of their activity on the Web involving music and audio content (Bhattacharjee, Gopal, Lertwachara, & Marsden, 2003).

Piracy in the motion picture industry became problematic approximately one decade after surges

in music piracy (White, Rao, & Minakakis, 2010). The Motion Picture Association of America (MPAA) estimates that several billion dollars are lost worldwide each year due to online movie piracy. Generally, pirates copy films from DVDs or film them directly in theaters (a process known as 'screening'). Once copied, the pirates can upload these films to the Internet. Mexico, Russia, and the Ukraine are recognized as the most problematic regions, with Russia identified as the primary source of pirated movies worldwide (Fuchs, 2011).

With advances in broadband technology, piracy by way of video streaming has also become a significant threat to the motion picture industry. Currently accounting for 1.4% of global online bandwidth, piracy in video streaming eliminates the need to illegally access movies through file download (Filloux, 2012). As argued by Sandra Aistars, Executive Director of the Copyright Alliance, "illegitimate distributors are increasingly turning to streaming to deliver works because it is faster, cheaper, and more convenient" (Chaudhry, 2012). Recognizing this growing threat, Congress sponsored The Commercial Felony Streaming Act in response (Chaudhry, Chaudhry, Stumpf, & Sudler, 2011).

The print media industry has recently joined the ranks of those fighting against online piracy. Google's drive to scan books for its digital library, Google Books, was the first major challenge of copyright infringement for print content online (Hellman, 2012). With the advent of e-books, authors have now become concerned that e-versions of their publications can be more easily pirated, eating into their publication revenues. A Verso

**Figure 2.** Percent of potential software market lost to piracy across nations

Source: Business Software Alliance (2012)

Digital Survey reveals that “28% of eReader owners use unregulated torrent services” (Attributor, 2012). The International Data Corporation estimates that over 35.1% of e-books downloaded in Spain are pirated (Llewellyn, 2010). As a result of online piracy, it is also estimated that technical and science publications lose about \$1.7 million and \$1 million per title, respectively, each year (Attributor, 2012).

The software industry is heavily impacted by online piracy, too, because false product in this sector relies on copying programmed instructions rather than the quality of those instructions. If a software code is reproduced in its entirety, then the functionality is successfully pirated with no loss of perceived quality. Consider Microsoft, which has struggled with piracy of its various applications. In China, Microsoft loses over 50% of its regional-based revenues due to rampant piracy. The Chinese government has shown little effort to stop offenders, other than issuing a warning. The Business Software Alliance projects that digital content proliferation, increased Internet usage, and growth in broadband speeds will continue to heighten software piracy. These trends are particularly true for emerging markets such as Russia, India, and China (Figure 2).

## 2. Down memory lane: A brief history of piracy

Although piracy has become a major threat to numerous industries, piracy itself is not a new phenomenon. Even before the digital revolution or introduction of the World Wide Web, piracy was prevalent. Interestingly, markets seemed relatively accepting of piracy as part of supply chain ecosystems. Irrespective of negative impacts, piracy

helped promote brand awareness and product acceptance in the marketplace. Prior to the digital age, pure information assets all experienced piracy, yet because of limitations in reproduction quality and distribution channels, industries were relatively tolerant of offenders.

For instance, during the 1980s, cassette tapes were widely used as a storage medium for music. It was common for music enthusiasts to tape their favorite tunes from the radio, LPs, and other sources. When consumers were able to purchase dual cassette recorders, music buffs not only created pirated recordings, but also duplicated them as many times as desired. Pirates would casually copy cassettes for friends or package them more professionally for sale. Regardless of these disturbing trends, the music industry remained healthy. Music producers operated with little concern primarily because copying analog cassettes noticeably degraded sonic quality. Creating copies of copies typically degraded sound to the point that consumers eventually found duplications unacceptable. The inability to mass produce high quality copies from a pirated source inherently limited the spread of music through piracy networks. Furthermore, distributing pirated music via cassettes was usually limited to local regional markets because of high shipping costs to send cassettes over long distances. Only recently has the Internet facilitated very low cost global distribution. Historically, the music industry has been generally tolerant of piracy as a sub-current in the music supply chain, provided such illegal activity operated within acceptable limits.

Regarding the motion picture industry, video cassettes made films quickly susceptible to piracy. Pirates engaged in reproducing movies from legitimate VHS tapes. Theater recording, or *screening*,

became possible when video recorders were made small enough for people to conceal in movie theaters. These bootlegs would often be sold through underground shops, flea markets, and personal networks. Cable television services also became a target for piracy. Pirates recorded movies from cable channels and sold them through piracy networks. Though damaging to the industry, these forms of analog reproduction were limited by virtue of quality degradation. Physically sharing or selling pirated cassettes also tended to be concentrated in local regional areas, where exchanges occurred on a face-to-face basis.

Movie piracy may be spurred, in part, by long delays caused by the motion picture industry's standard schedule of distribution to certain regional markets. These regions, finding the wait unacceptable, respond by resorting to piracy in order to gain timely access to popular films. For instance, a typical supply chain in the U.S. runs a movie in select theaters for 4 to 6 weeks. The movie is then distributed as home video approximately 5 to 6 months after theater runs. The movie becomes available through Pay-Per-View channels approximately 1.5 months after home video distribution. Then, 3 to 4 months later, the movie is distributed through Cable services such as HBO, Cinemax, and Showtime. Finally, a full year out, the movie is distributed through Syndicated television networks. If consumers in certain regions, either domestic or international, cannot afford to access the movie or are unwilling to wait until the film becomes available 'at a theater near you,' piracy becomes a real option (White, Rao, & Minakakis, 2010).

The print media has also endured a long history of piracy and consumer complicity, most of which has not been threatening to the industry until recently. Reproduction of printed matter became a topic of interest when high speed, high quality black and white copy machines were invented. The general public could then quickly reproduce books, magazines, newspapers, journals, and newsletters—in part or in full—without acquiring permission from the copyright owner. As long as the copies were sufficiently legible, readers were satisfied because they could consume the desired information. Likewise, the print media industry was tolerant of these acts provided that readers refrained from large-scale piracy. Publishing companies reserved legal action primarily for enterprise-wide offenses whereby high value publications were photocopied and distributed or sold to large audiences, hence disenfranchising the publisher.

Software as a digital asset has always been a target of piracy. Provided that users can copy software code completely, the software can be

successfully pirated. Reproduction quality is not a factor since software piracy depends solely on duplicating the software's instructions in its entirety. Software piracy included copying application suites, where such content would be sold in computer shops, shared with friends, or installed on personal hardware. Aside from warning messages, software producers adopted various digital rights management (DRM) systems to prevent users from freely running pirated software. As Internet access increased dramatically with the introduction of the World Wide Web, software piracy became even more problematic. Sharing and selling pirated software was no longer limited to local underground shops. Pirates could exchange whole application suites over an international network. Since then, P2P sharing sites, Bit Torrents, and direct downloads have become increasingly popular ways to illegally share massive volumes of pirated software.

Pure information content has always been subjected to acts of piracy. Historical tolerance of piracy has been a direct reflection of limitations around content manipulation. As content format went digital and distribution moved to the Internet, online piracy exploded. The high demand for pure information content, coupled with the advantages of digital formatting and the ubiquity of the Internet, has given rise to accelerated piracy rates (Ng, 2012).

### 3. A change in the supply chain ecosystem

The supply chains for music, motion pictures, print media, and software have been altered due to two major paradigm shifts: the arrival of digital media and introduction of the World Wide Web. In addition to these shifts, increased network bandwidth has empowered people to transfer large data packets within short periods of time. The Internet, in particular, has also enhanced people's ability to consume pirated goods anonymously. Anonymity itself has fueled consumer complicity, permitting Internet users to search freely for pirated content without fear of retribution. These technological shifts have furthermore allowed global access to pirated goods that truly rival the originals and extend access across international borders. As piracy reaches historic levels, we find that consumer complicity has not suddenly shifted; rather, the momentum has much to do with impacts of technology paradigms on the consumer's fundamental decision to purchase. These decision factors include perception, product availability, cost, and quality. They have all changed in large part due to the digital and Internet paradigm shifts.

Depending on perception, piracy itself can be a double-edged sword. On one side, it has the potential to cripple sales and dismantle whole industries. On the other, it has demonstrated the potential to increase product awareness, leading to a causal effect of stimulating sales and boosting product familiarity. Several examples underscore this paradox. Consider that radio stations have been regarded by artists as a vehicle toward becoming a household name. Repeated air play ensures that millions of listeners recognize a tune and, most likely, the performer behind it. Fans rush out to buy the song. Yet, ironically, the music industry has been at odds with radio stations for years. The former accuses the latter of playing songs without permission and not sharing revenues. In a sense, record labels have regarded radio stations as a form of piracy and a danger to the industry as a whole.

Regarded as the first real P2P threat to the music industry (Yang, 2011), Napster embodied this dynamic on a different level. Leading up to the entity's folding in 2001, the music industry emphasized potential sales losses at its hands when in fact a number of artists actually benefited from Napster. Several music groups, for instance, went from obscurity to Top 10 sales charts due to illegal P2P file sharing over Napster during the late 1990s. These artists were able to gain substantial exposure without launching large marketing campaigns. Because peer-to-peer file sharing made it easy to distribute popular tunes among a growing fan base, Napster made it possible for certain artists to substantially increase sales and recognition.

One must also appreciate how consumers may use piracy in the process of consumption. For instance, although unauthorized recordings may diminish sales in the music industry to some extent, studies have shown that a majority of people who copy music subsequently purchase the artists' songs legitimately ("Why Is Piracy," 2009). Certain individuals even consider piracy as healthy for increasing product awareness and performers' fan bases. A 2011 Anti-Piracy & Content Protection Summit survey (<http://www.antipiracycontent-summit.com/>) asked people how those in their work environment felt about piracy. The results reveal that over 50% of those surveyed believe piracy is inevitable and over 14% surveyed believe piracy serves as a useful form of free marketing. The supply chain ecosystem is defined by more than the major industrial firms in the ecosystem. Consumers have a vote, and this is based on perceptions of what is right and wrong. For as long as people view piracy as potentially beneficial to the industry, they will continue to pirate.

## 4. Resistance to digital rights management

Another trend reveals that both consumers and companies are resisting traditional digital rights management (DRM) systems for the following reasons.

### 4.1. DRM fails to prevent piracy

One of the arguments against employment of digital rights management systems is that they fail to prevent piracy. While a number of measures have been taken to prevent unauthorized users from copying digital content and distributing it over the Internet, these DRM approaches have in many instances been easily compromised. As a rule of thumb, anti-piracy technologies relying solely on tokens, tags, and watermarks embedded within pure information content are ultimately undermined by technologies designed to remove those locks (Ogren, 2009).

### 4.2. DRM discourages legitimate buyers

Studies have shown that digital rights management systems potentially deter honest consumers from purchasing legitimate content. Authentication, regional settings, and limitations on the number of installations allowed pose inconveniences to legitimate buyers. The side effect is that these inconveniences indirectly encourage legitimate buyers to seek pirated content online or not buy the content at all. Contrary to intention, DRM systems have not necessarily motivated consumers to buy legitimate. This trend underscores the complexity of piracy and the need to address the more fundamental issue of evolving supply chain ecosystems.

### 4.3. DRM increases cost of management

Companies using digital rights management systems must carefully measure the cost impact of such solutions on profit margins. To put it simply, DRM systems can inflate company costs (Ogren, 2009). Implementing DRM solutions and funding related IT services can quickly erode profits and potentially threaten the content owner's overall business model. In response to these concerns, a number of companies have been reevaluating their use of DRM systems. The lesson here is that digital theft management is more complicated than just preventing pirates from undermining sales. Rapidly growing piracy is a reflection of a sudden and fundamental change to supply chain ecosystems,

spurred on by the digital revolution and the Internet. The fact that piracy is difficult to control reflects industries' general lack of preparedness for this sudden change. Understanding this complexity is, in part, acknowledging that piracy has always played a role in consumer decision making. Anti-piracy solutions should, therefore, focus on exploiting piracy within acceptable ranges while attempting to limit excessive levels of piracy.

## 5. Rethinking solutions to online piracy

Solutions must not necessarily be driven to completely eliminate piracy, but rather to maximize revenue in the presence of 'managed' piracy. Managing piracy involves keeping it within acceptable limits relative to the health of industries. To this end, online piracy is the area in which significant management solutions are required. Online piracy solutions under the new ecosystem involve finding methods and technologies that increase the value of legitimate assets compared with their pirated copies. Several models are being adopted that benefit industries in the face of piracy. We explore these next.

### 5.1. Employing the advertising model

Online streaming video service Hulu demonstrated that, provided a choice, people are willing to acquire content legitimately. "The original idea behind Hulu was to give viewers a legal, TV-on-demand free-streams alternative to downloading pirated content, which appears to have worked" ("Why Is Piracy," 2009). Although Hulu has recently become a fee-based service with free trial offerings, the potential exists for other non-paid streaming video services to fill the gap and counter piracy. Consumers are already familiar with the advertising model Hulu uses based on traditional television and radio. Although some consumers may resist commercial interruptions, most have shown they are willing to accept some level of embedded advertising rather than view pirated videos. It takes far less time to access streaming content from a well-managed hosted service than it does to seek out and download hours of illicit material. Such convenience plays a key role in consumers' judgment when deciding whether or not to pirate.

In numerous cases, the advertising model is spreading with high levels of consumer acceptance. YouTube, a source of many uploaded videos—not all of which are legal—has also adopted an advertising model. Ads appear before and during specific videos when played. This allows advertisers to target intended demographic audiences based on video

content. Growth of the online advertising model demonstrates that industries are adjusting to the shift in the supply chain and are finding alternative ways to achieve revenue.

### 5.2. Giving the consumer what they want: Value and convenience

Apple has adopted a unique approach to handling online piracy through its iTunes Match service. Announced in 2011, iTunes Match can scan a user's hard drive and identify those songs found in Apple's vast iTunes repository. Matched songs can then be made available on other Apple devices, such that a customer may access their favorites on any Apple platform. Rather than limiting users to only 'legitimate' songs, Apple disregards whether or not a user's songs are pirated. Charging each customer a \$25 annual service fee, Apple turns over 70% of iTunes Match revenues to the music industry. This model works because it leverages piracy rather than punishing the consumer for it. The key to the model's success lies in the fact that Apple has found a service many music enthusiasts are willing to pay for: access across multiple platforms. Ultimately, users feel they are paying for accessibility, when in actuality they are paying for the songs.

The anti-piracy solution is essentially a combination of cloud computing technology and access management that adds value to the consumer. This added value shifts the overall value model such that the consumer pays for content he/she may not have otherwise. The overarching effect is that growth in piracy under this model has little to no negative effect on the industry. To the contrary; the music industry can recover significant revenues by virtue of consumers' demand for accessibility. Of course, not just any consumer electronics firm can offer this solution. Apple brings a unique asset to the table: over 25,000 songs in its online repository, making the possibility Apple has your songs—whether they are pirated or not—highly probable. According to Jeff Price, CEO of TuneCore, Inc.: "If only 10 percent [of Apple iTunes customers] signed up for the convenience of accessing music they hadn't bought there, it could turn into more than \$500 million a year in new revenue" (Nakashima, 2011).

What's more, iTunes Match not only leverages piracy for the benefit of the music industry, but also feeds off it. If a consumer cannot find a duplicate in the extant iTunes Match repository, the user can simply upload the song and thereby increase Apple's mammoth library, making it available through the cloud computing service for a fee. This model not only holds potential for the music industry in how to deal with piracy, but may offer a solution for other

industries where consumers value accessing content over multiple devices.

Most recently, Apple has entered into talks with producers to license music for a new online radio service that would be freely accessible by users, but would incorporate advertisements. The customizable radio service would work across Apple's numerous platforms, including iPhones, iPads, and Mac computers. The creation of custom online-radio services is a growing trend, already spearheaded by competitors like Pandora, Spotify AB, and iHeartRadio (Smith & Vascellaro, 2012). Unlike Pandora, however, Apple's approach aims to sidestep licensing fee arrangements by directly negotiating terms with music producers. It also seeks to offer more flexible access to popular music, giving consumers additional value for the service. Apple, the world's largest music retailer, is making inroads toward finding ways to leverage its massive online-music sales to attract consumers to legitimate forms of music consumption (Smith & Vascellaro, 2012).

### 5.3. Establishing adequate limits of applying takedown services and supporting technologies

Another effective anti-piracy model entails utilizing takedown services. One of the more proactive steps a content owner can employ is to simply remove unauthorized content from the Web wherever it is found. These solutions, however, cost both time and money to implement. It can also be assumed that pirates will simply move the content and post it elsewhere soon afterward. Therefore, takedown services and the technologies that drive them are best limited to situations of runaway piracy, when levels have exceeded healthy limits for a particular industry. Determining what these 'healthy limits' are depends on how well industries can exploit different levels of piracy to recover revenue.

A number of takedown services combine legal advisory with anti-piracy technologies to seek, identify, and remove pirated content from the Web. "Digital content protection services such as Contributor, Covington & Burling, and BayTSP all provide technology that searches direct download sites daily looking for unauthorized copies of digital content" (Contributor, 2012). Covington & Burling, for example, has an anti-piracy enforcement group that is "comprised of in-house investigators, seasoned attorneys, and state-of-the-art software tools" to remove pirated content from the Web on behalf of content owners (Contributor, 2012). A number of similar services and watchdog organizations monitor the Internet to detect piracy, responding with a 'notice-and-takedown' process (Ng, 2012).

Recent technologies lend such anti-piracy initiatives more credibility. For example, NEC has greatly enhanced takedown services for video content by developing a rapid digital video fingerprinting technology. Known as Media Serpla, this software can scan "1,000 hours of video. . . for a five second clip in about a second on a standard desktop computer" (Alabaster, 2012). Piracy detection can be achieved with exceptional accuracy for a video clip lasting as little as 2 seconds. NEC has further enhanced its digital video detection software with content removal tools, giving takedown services a complete automated takedown process. In 2011, Baidu Inc. announced a similar technology that will remove pirated e-books from its Baidu Library, as well as reject future uploads of copyright-infringing content ("Baidu to Introduce," 2011).

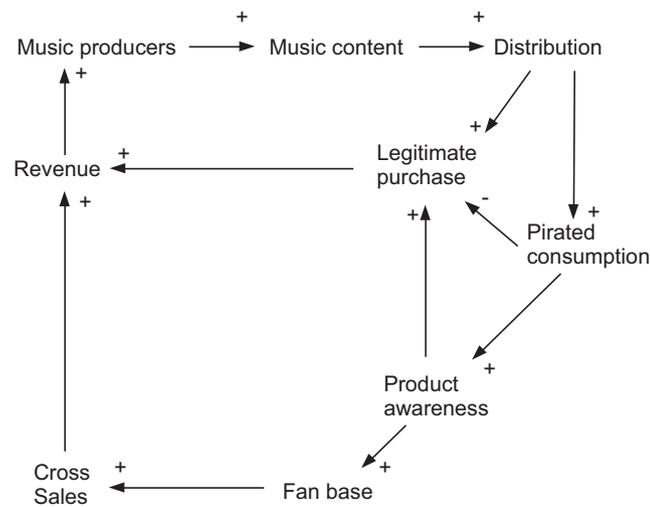
### 5.4. Adopting a systems modeling approach: Follow the math

The combination of leveraging piracy within acceptable limits and limiting piracy when excessive requires a new systems modeling approach that can optimize management of online piracy. Piracy's impact on industries has complex causal effects involving consumer value systems, technology, and enforcement. All complex models demonstrate multiple levels of cause-effect relationships, which are best understood using system dynamics modeling. Under the new supply chain ecosystem, industries can leverage piracy to generate revenue. Leveraging piracy, however, depends on the rate of piracy a particular industry is experiencing, and what alternative models the industry can use to exploit piracy for its benefit. When piracy reaches unhealthy levels for an industry, system dynamics modeling can reveal when industries should invest in more 'notice-and-takedown' initiatives.

Given the uniqueness of various industries, these system dynamics models must be tailored to address industry-specific supply chain ecosystems. What works for the music industry, where sonic quality impacts consumers' decisions to pirate, may not apply to the software industry, where content quality is not a factor. Industries are generally self-correcting by virtue of supply and demand. When exposed to high levels of piracy, however, industries may not have the time to adjust to a rapidly changing supply chain ecosystem. System dynamics modeling can help industries identify thresholds of sustainability and adjust more predictably. For example, cause-effect relationships in the music industry can be modeled using system dynamics to measure cause-and-effect relationships between music

Figure 3. System dynamics modeling approach applied to piracy management

Modeling the effects of piracy on the music industry supply chain ecosystem



sales, piracy, market awareness, and revenue recovery techniques (Figure 3).

## 6. Conclusions

If history has taught us anything, it is that piracy is not a new phenomenon. Music, motion pictures, print media, and software all experienced copying well before these industries expressed concerns over pirated goods. People are not catalysts of rising piracy; new technology is. In particular, the digital revolution has allowed consumers to copy pure information content with superb quality, making it nearly impossible to distinguish between the real and the reproduction. The World Wide Web has introduced a new means of sharing digital content, some of which is pirated, across borders. Finally, rapid growth in bandwidth has allowed Internet users to transfer more digital content online in less time. The capabilities afforded by these technology paradigms have opened a Pandora's Box, and now that the box is open, it will be hard to ever again contain what it has unleashed: online piracy. What is needed is a reassessment of how these paradigms have changed the very nature of industries and their respective supply chains.

First, we must recognize that traditional supply chains have been permanently altered. New supply chain ecosystems permit faster fulfillment and new distribution methods. Conversely, these new ecosystems can be easily disrupted by consumers who decide to pirate content rather than buy it. The decision to pirate is based on evolving perceptions involving value, cost, convenience, and availability. Traditional anti-piracy technology to prevent illegal

copies has achieved mixed results in these new ecosystems. Digital rights management proves to be ineffective at preventing piracy on a grand scale. What is worse, DRM can discourage legitimate consumers from buying at all and saddle companies with IT support overhead.

The solution to piracy lies neither in imposing draconian methods that seek to eradicate the problem altogether, nor simply resigning ourselves to runaway conditions. Rather, the answer rests in combining appropriate technologies with new business models designed for the new supply chain ecosystems. Hulu and Apple have demonstrated that technology applied through new business models can actually fight piracy by leveraging it. By changing the rules, piracy can increase fan base, product loyalty, and—ultimately—sales. NEC has also introduced technologies that strengthen takedown services. The combination of innovative business models and content availability tools can put industries back in the driver's seat of their supply chains.

The evolution of piracy solutions will be fortified by using system dynamics modeling of various industries to know when and how to combine innovative business models and anti-piracy technology. The piracy problem has proven to be greater than previously understood. Solutions will require much more than using DRM or any single technology as a silver bullet. Instead, controlling piracy rests with modeling the complex cause-and-effect relationships between content value, product availability, factors of piracy, product awareness, brand loyalty, sales, and profit margins. Only a thorough analysis using system dynamics modeling and adoption of new methods appropriate for evolving supply chain ecosystems

can identify the best course of action for industries combating piracy.

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