Whatever happened to payola? An empirical analysis of online music sharing

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Abstract

The popularity of online music sharing networks has attracted interest from the music industry, artists, consumer advocacy groups, the popular press, and government legislative and regulatory entities. P2P networks have become lightning rods for debates on intellectual property rights and music market fates. Yet, to date, little has been based on actual observed activity on online sharing networks. Here we report on an initial P2P network data gathering and analysis endeavor and relate it to market performance of music albums. The relative market performance of music albums is gauged using the list of top 100 albums on the weekly Billboard charts. The P2P sharing data gathered is longitudinal, spanning a period of 8 weeks. We also identify and track data for 47 upcoming album releases providing pre and post release comparisons of sharing activity. We offer four main findings:

(1) significant piracy opportunity and activity were observed;
(2) the level of sharing opportunities are related to albums' relative chart positions;
(3) there is evidence of both "pre purchase sampling" piracy and "lost sales" piracy; and,
(4) sharing activity levels provide leading indicators of direction of movement of albums on the Billboard charts.

Points (3) and (4) have particular implications for music marketing and promotion.

Keywords: Online consumer behavior; Music industry; Sampling; Piracy; Advertising; Entertainment marketing; Internet marketing

1. Introduction

Alan Freed was a music "point man". He is credited with being the first to coin the term "rock-n-roll". He was also the first to take a fall in the famed

"payola scandal" of the 1960s. As "pay-for-play" debates once again have come to the fore (see, for example, "Pay For Play" [2]; "Payola Controversy Heats Up" [16]), one is reminded how much emphasis record companies have placed on getting their music sampled and heard by the public. Yet, in one significant arena enabling widespread sampling, the record companies have chosen a very different tact, perhaps best described as *all out war*. In peer-to-peer file-sharing computer networks (P2P), participants can download as a means to sample wide arrays of music and subsequently make more informed music purchases. But, as many record companies argue, participants can also download as a means to obtain the record companies' product without paying for it—they can digitally *pirate* the music. Note: In P2P networks, files are hosted across a loosely connected network of computers, with no central monitoring or connection service. The catalog of files stored on the network may be available centrally or distributed across several computers on the network.

Music is a hedonic product whose evaluation is based primarily on the experience it provides to a consumer rather than on specific product attributes [5,18]. Consequently, sampling of music is an important influencer for consumer purchase decisions. This has prompted record companies to employ radio airplay as a primary form of advertisement [19]. Since well before the 1960s, individuals had the capability to record radio broadcasts on tape recorders. Quality, however, was not very good and record companies seemed to have taken little note. As technology improved with the advent of high quality tape decks, record companies began to take interest and strove to develop embedded signals that lessened the value of reproductions of commercial music cassettes. Technological improvements have continued to enhance consumers' capability to copy and share music products. But prior to today's P2P environment, copying required acts of "borrowing" and "returning" " between trusted individuals—not always popular and certainly not prone to mass activities. Now, P2P networks have raised the possibility of sharing to entirely new levels and the music industry has repeatedly raised the alarm, calling for enhanced enforcement of existing regulations (for details, see Refs. [3,22,30]) and the introduction of additional legislation (for details, see Refs. [7,8,28,30]). As reported in Ref. [14], in a US Senate hearing on February 28, 2002, Disney Chairman and CEO Michael Eisner went so far as to term digital-age piracy an "unimaginable threat" that necessitated enhanced legislation.

But what do we really know about the impact of music file-sharing on peer-to-peer networks? Is it possible that these exchanges actually serve as significant sampling mechanisms for individuals who, based on this "trial listening" information, subsequently purchase the higher quality production good [17]? In fact, Peter Fader's expert report to the court in the Napster case suggests such positive impacts [6]. To date, we know of no analysis utilizing data collected from observing activities on peer-to-peer music sharing networks. It has been observed that while radio airplay, as measured by Broadcast Data Systems, measures the advertising effort for given music albums [18], airplay does not closely measure consumer interest in such albums [29]. In fact, anecdotal evidence points to misjudgment of consumer interest and related promotional activities of new artists and albums by record companies (see, Refs. [15,25,31], for example). Given the increasing interest in marketing hedonic products [9,11,13,21,23], we posit that observed "trial listening" information from P2P networks may be used to predict consumer interest and subsequent sales for music albums. Music is unique and different from, say, motion pictures as consumers need significantly less time to sample and repeatedly listen to the same music (over a period of time), hence sampling is a natural prelude to subsequent purchase. It is also different from software as it takes much less skills to enjoy music, it is smaller in size and hence easier to share and sample, and the volume of available music is significantly larger than the volume of available software. Hence sampling before purchase is an innate characteristic of music.

The music industry repeatedly cited lagging CD sales as clearly due to piracy (see Refs. [12,26] for example). Jay Berman, IFPI (International Federation of the Phonographic Industry) Chairman, argued:

> . . .the industry's problems reflect no fall in popularity of recorded music: rather they reflect the fact that the commercial value of music is being widely devalued by mass copying and piracy. [27]

During the 2002 Grammy Awards, Michael Greene, CEO of the National Association of Recorded Arts and Sciences (NARAS) suggested, "The most insidious virus in our midst is the illegal downloading of music on the Net" [10]. But there are a variety of other explanatory factors for declining CD sales including cited decreases in new album releases by major labels, a generally sluggish economy, and pricing issues [4]. Very recently, Ref. [24] offered the following information on new releases:

Figures posted on the Recording Industry Association of America's website reveal that the number of new US music releases has fallen by 31 pc to about 27,000 from 38,000 in 1999. Throughout the 1990's, the trend was for the number of new releases to rise.

Mike Shalett, president and chief executive of SoundScan, suggested the inevitable quality issue in his comments that, quite simply, he did not think "the music was as exciting in 2001" [20]. Despite claims of piracy on P2P networks, a recent article suggested that the music industry may actually be trying to collect and utilize "trial listening" information from P2P networks to predict sales [29].

The research reported on here provides a first detailed analysis of the relationship between observed music-sharing opportunities and activities on a specific and active P2P music sharing network *and* positions and direction of movements on the weekly Billboard charts, a ratings profile based on weekly sales estimates. That is, we collect consumer P2P sharing behavior data and investigate relationships of the observed behavior and market sales performance. Our focus is on investigating whether (and, if so, how) the level and changes of music sharing opportunities tends to lead, correspond to, or perhaps lag sales as measured by position and movement on the Billboard charts. In industry terms, we are investigating whether data on file-sharing opportunities is possibly consistent with positive sampling (advertising) opportunities or does the data suggest pure piracy and negative impacts on sales? In marketing terms, we are investigating whether data on file-sharing activities can serve as leading indicators of album sales. If so, can such data serve as inputs to improved decision making in directing the industry's substantial marketing and promotion dollars?

The data is longitudinal and, as explained below, was collected by a passive "observe and capture the information" program we developed. We neither participated in nor interfered with the activities on the network. Section 2 carefully describes our data collection procedures. Section 3 provides initial analysis of the relationship between our observed P2P network activity and changes in positions on the Billboard charts. We find that both the level of file-sharing is related to position on the Billboard charts, and that the level of file-sharing is a predictor of movement in the Billboard charts, and hence, sales. Further, counter to the pure lost-sales piracy claims of many record companies, our analysis suggests the presence of both "lost sales piracy" and positive "pre-purchase sampling piracy." This finding is of significant importance given annual music market revenues of approximately US$14 billion in the US alone and US$40 billion worldwide [32]. It is also timely given claims of piracy by major music labels (identified earlier), ongoing legal actions against P2P networks and persons sharing files [1], and introduction of legislation to enhance enforcement of intellectual property rights of digital products (identified earlier).

2. The data

Our data come from two sources: WinMX P2P network and the top 100 albums on the weekly Billboard chart. The following sub-sections describe the two data sources and the procedures we used to capture the necessary data.

2.1. WinMX network

WinMX is one of the popular file-sharing P2P applications. On a recent weekend, multiple observations (two each day from Friday to Sunday) indicated an average of 457,475 users sharing 303,731,440 files. Individual WinMX users can launch sharing services by joining a decentralized network of file-sharing. WinMX features functionalities that allow users to search, share, and/or download files.

Once WinMX is installed and launched on the user's personal computer, he or she is connected to

multiple networks providing access to other computers and their shared files. The number of connected networks depends on: (1) the networks' topology, and (2) the networks' current traffic. The user can conduct a "keyword" Boolean search. Though any keyword may be entered, in the music-sharing environment one would expect typical keywords to include the name of a recording artist, the title of a specific song, or the title of a specific album. The WinMX search process searches through computers currently connected to the network and provides a list of all audio files that meet the search criteria and that are available for sharing. An example of part of a search result for the artist/title "Dixie Chicks Home" is shown in Fig. 1.

As illustrated in Fig. 1, each search result element (audio file) found from a WinMX search typically contains the following information or data that we captured:

(1) File: the filename as it appears on the P2P sharer's computer;
(2) Bytes: the size of the audio file in bytes;
(3) Time: estimated play length in minutes and seconds;
(4) Bitrate: indicates how many bits are used to represent one second of music;
(5) Freq: the sampling rate at which the digital file was created from its original format;
(6) User: name (or pseudonym) of the WinMX sharer making this audio file available;
(7) Speed: indicates the speed of the sharer's internet connection;
(8) Ping (Packet Internet Groper): a standard TCP/IP protocol function that indicates the response time for the sharer's computer (in milliseconds);
(9) Status/Server: the sharer can choose to limit the number of files that can be simultaneously downloaded from his computer. This data field reports this limit as well as: (1) how many files were being downloaded from the sharer at the time of the search result, and (2) how many requests were pending for download from the sharer. For example, "4 of 6 available" indicates the user allows six files to be downloaded simultaneously and at the moment two files are

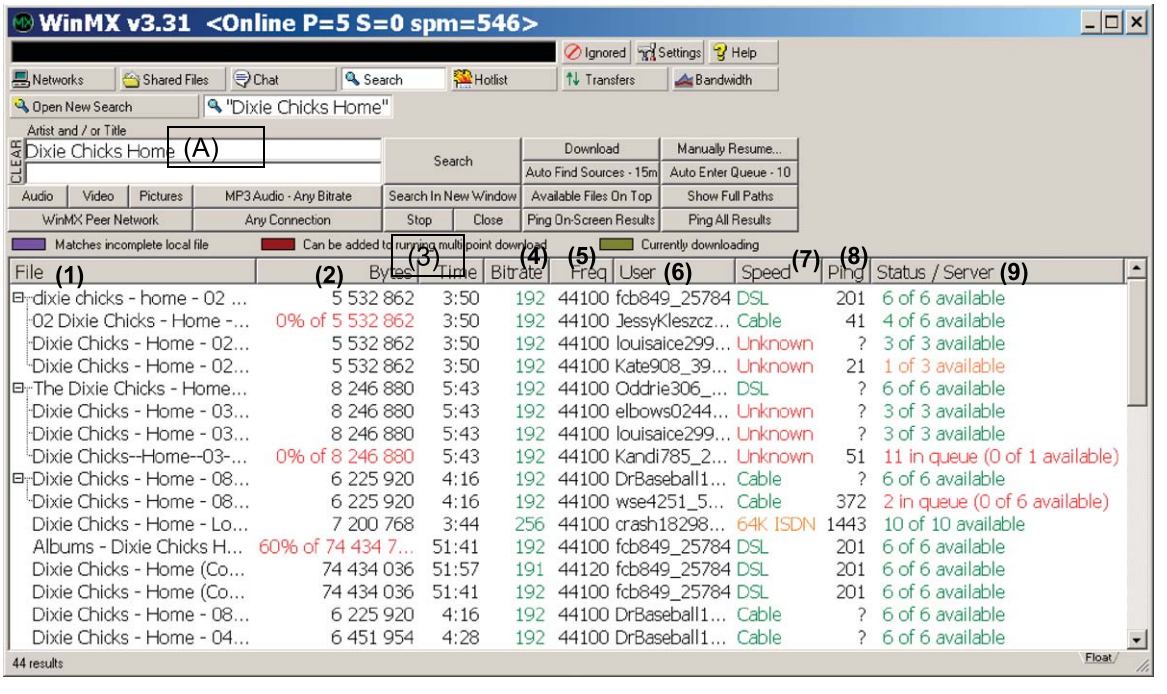

Fig.

being downloaded from his computer. Also, "2 in queue (0 of 6 available)" means six files are being downloaded and two additional download requests are waiting to be executed.

Item (A) in Fig. 1 is used in Section 3 to help explain the search process. As detailed below, we focus heavily on the total number of audio files (a count across (1) above) resulting from an album name keyword search and on two elements or outcomes included in status/server (item (9) above)—the number of channels provided by a sharer (number of simultaneous downloading activities permitted) and the length of the queue waiting to download from the sharer's computer.

Although other popular file-sharing applications exist, WinMX was chosen specifically for this project for several reasons. First, some applications (such as KaZaA and Grokster) have a fixed limit of how many files can be shown on any given search result. This would not allow us to fully measure the popularity of music on the network. Second, other applications (such as Morpheus and AudioGalaxy) have gone through legal and technical turbulence in recent months, creating an unstable environment for data collection. In addition, WinMX indicates the queue status on individual computers and real-time downloading activities. This allows us the possibility of a measurement of the demand for music files without having to track individual users or to engage in any actual (and inappropriate) exchange of copyrighted materials.

2.2. WinMX data collection methodology

In order to analyze the file-sharing behavior, we developed a Windows-based application program to automate the search process for audio files available on WinMX networks. Our application used the list of keywords from the Billboard charts (see below, Section 2.3) to conduct a Boolean search for copies of songs on albums appearing on the Billboard chart that week or in a previous week within our search period. The search was conducted daily from October 25, 2002 to December 22, 2002 for each of 100 albums for the applicable weekly Billboard chart. The announcement of each week's Billboard chart signified a new week of data collection, a week that was ended with the announcement of the subsequent Billboard chart. It is important to note that our application captured only the file information described above and did not involve downloading any copyrighted content from any computer on the WinMX networks. After we recorded each search result, we compiled the data into an Oracle data warehouse.

2.3. Weekly billboard charts

The list of top 100 albums (in sales) on the weekly Billboard chart was obtained from the official Billboard web site that can be found at http://www.billboard.com/bb/charts/bb200.jsp. The site provides the list of the top 100 albums at no charge. While a fee-for-service option exists to obtain the entire top 200 albums listed each week, we focused on the top 100 since these are freely available on the web and easily accessible to P2P users. The Billboard chart ranking is based on "...a national sample of retail store sales reports collected, compiled and provided by Neilsen Soundscan" (from Billboard website mentioned above). The information collected includes the name of the album sold, the number of units sold and the week of the sale. The information on the Billboard chart includes the current ranking, previous ranking, total number of weeks on chart, artist's name, album's name, and peak ranking of each album.

3. Variables and data gathering

In our introductory remarks, we suggested that music companies are focusing on the piracy aspect of P2P music networks while seemingly ignoring the sampling or pre-purchasing activity. In light of the history of the music industry in fostering sampling, even using illegal means to spread the sampling activity, it may be the case that the industry is overlooking a sampling activity that costs them nothing and which reaches a very wide audience. Our task in this section is to analyze the longitudinal data we capture to determine if there are values or patterns that can help us identify activities consistent with sampling, or piracy, or the likely presence of both.

What is of interest to the music industry is sales, but the industry does not publicly provide that information.

What we can obtain are the weekly Billboard chart values that measure sales in the relative sense among the top albums for the week. For our work, we focused on Billboard's weekly top 100. We investigated a variety of ways to measure the success of an album including the simple Billboard ranking groupings for a specific week and various comparative measures of movement up and down the chart groupings from week to week. Table 1 provides a list and explanation of the dependent variables we analyzed. Table 2 provides a list and explanation of the explanatory variables used in our analyses.

As part of data gathering, we structured an automated process that repeatedly checked the Billboard web site for the posting of each week's new chart. Since we are studying on line activity, we use the web posting of the Billboard chart rather than the print version of this chart. The web version appears approximately 1 week prior to the print version. Utilizing a time stamp, we observed the following posting times (or first observation times) for the 8 weeks in our sampling period:

Friday, October 25	10:35 am
Saturday, November 02	3:13 pm
Saturday, November 09	9:18 am
Friday, November 15	9:56 am
Friday, November 22	1:28 pm
Saturday, November 29	8:19 am
Saturday, December 7	6:33 pm
Saturday, December 14	3:22 pm

The postings ranged between early Friday and late Saturday for any given week, each week. Thus, to avoid comparing data that was "pre-Billboard chart posting" 1 week with data that was actually "post-Billboard chart posting" the next week, we do not include any Friday, Saturday, or Sunday sharing availability data in our analyses. The sequence of our data collection is as outlined in Fig. 2.

Our tracking process gathers data on the sharing availability on WinMX for an album once it appears on the Billboard charts and continues tracking until the end of our 8-week observation period. In other words, the initial appearance on the Billboard charts serves as the trigger for our tracking process. For example, if an album titled "Frank Bass' Lectures" first appears on the Billboard chart in week 3, then the sharing availability is tracked for weeks 3 through 8 whether or not the album was listed on the Billboard charts in any or all of the results posted for weeks 4 through 8. By tracking this way, we are able to gather data on albums that remained in a given grouping or moved out of that grouping over any specific week period—e.g., data on albums that remained in the top 20 in weeks i and i+1, $T20_iT20_{i+1}$, or albums that fell from the top 20 to the next 80 or completely off the chart from week i to week i+1, $T20_iB80_{i+1}D_{i+1}$. Using "piracy" terminology, our data gathering provides, for the first time, information on P2P sharing availability and a means to investigate possible relationships between this observed sharing availability and both position on and movement up or down the Billboard chart.

We gathered data on all albums that appeared on any of our eight Billboard charts. Before beginning our analysis of the data, we removed any "Greatest Hits" or "Various Artists" albums that appeared in any Billboard chart. This was done to avoid or at least limit confounding effects where individual songs by an artist or group would appear on multiple albums. Over the 8 weeks of data gathering, a total of 196 albums (after 19 Greatest Hits and Various Artists albums were removed) appeared at some time on the Billboard chart.

Table 1
Groups from the weekly Billboard charts

Group (g)	Description
$T20_i$	All albums ranked 1 through 20 on the Billboard chart in week i the Top 20
$T100_i$	All albums ranked 1 through 100 on the Billboard chart in week i
$B20_i$	All albums ranked 81 through 100 on the Billboard chart in week i the Bottom 20
$B80_i$	All albums ranked 21 through 100 on the Billboard chart in week i the Bottom 80
D_{i+1}	All albums ranked 1 through 100 on the Billboard chart in week i but do not appear on the chart in week i+1 the Drop-offs
$T20_iT20_{i+1}$	Albums ranked in the Top 20 on the Billboard chart both in week i and i+1
$T20_iB80_{i+1}D_{i+1}$	Albums that move from the Top 20 on the Billboard chart in week i to the Bottom 80 or drop off the chart in week i+1
$B80_iB80_{i+1}D_{i+1}$	Albums ranked in the Bottom 80 on the Billboard chart in week i and either remain in the Bottom 80 or drop off the chart in week i+1

Table 2
Variables representing sharing activity

Variable name	Description
$ADFA_i(g)$	For week i, the average daily number of files available for sharing on WinMX for albums in group g
$AQLS_i(g)$	For week i, the average queue length per sharer available on WinMX for albums in group g

Our data gathering involved observing, for each of the 196 albums, the complete results of a WinMX search using the keywords (artist and album name) from the relevant Billboard charts (see Fig. 1). At a time randomly generated daily for each album being tracked (under the constraint that no more time overlaps could occur than the number of dedicated machines utilized), we initiated a WinMX search for each of the albums being tracked. After a set time (5 min) sufficient to complete such a search, our process provided a full array of sites willing to share songs on that album. These results were then captured and recorded. Fig. 3 illustrates the key steps in our data gathering process. As noted above, once an album appeared on the Billboard chart, we continued to track it for the remainder of the 8-week data-gathering period. By week 8 we were tracking 196 albums. We used dedicated machines in the Gladstein MIS Research Lab, an environment utilizing a 100 Mbps ethernet connection with fiber optic uplinks to a 2 Gbps backbone. Using the notation presented in Table 1, for any specified album grouping, g, we could then construct the $ADFA_i(g)$ or average daily number of files available for sharing on WinMX during week i. This enabled us, for the first time, to analyze P2P network activity using data on the number of sharing sites available for songs on specific albums. In this paper, we report simple summary statistics (mean and standard deviation) of observations. Detailed statistical analyses on group differences have been conducted, and they are in accordance with the findings reported here.

4. Initial data analysis

In the introduction, we suggested that record companies had a history of fostering music sampling, a history of striving to get their music and albums heard. Sampling was viewed as a potent source of advertising, an important opportunity for consumers to "try and then buy". Yet today with a potent sampling tool—P2P networks—available, the record companies seem to have chosen to focus only on what they view as the "lost-sales" piracy threat of these networks. While it is certainly true that "lost-sales" piracy is an option for those using such networks, it is also possible that positive "pre-purchase sampling" piracy (sampling that leads to purchase) is also a major goal of those using P2P networks. Our analysis uses data gathered from one such P2P network to consider whether, in addition to "lost-sales" piracy, there is evidence of significant "pre-purchase sampling" piracy.

We are not able to observe whether a song from a specific album is being pirated at any point in time. Further, we are not able to determine what any individual is downloading at any specific point in time. What we can observe at any point in time, is how many sites are currently offering to share a song from a specific album. In addition, our data is longitudinal and includes daily observations of all albums once they appear for the first time during our 8-week period on the Billboard chart. With a few sporadic exceptions, record companies do not release album sales information. However, listing on the Billboard chart is based on sales and these listings can serve as relative success ratings for albums. We cannot observe actual album specific piracy activity but we can observe both the number of files for songs on a specific album available for sharing and the congestion (queue lengths) at

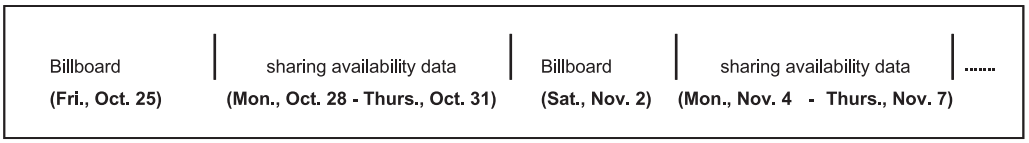

Fig. 2. Data collection sequencing.

STEP 1:	**Randomly select the start tIme**
STEP 2:	**Obtain and enter a keyword which is derived from the artist name and album title, on WinMX's input interface (item A in Figure 1)**
STEP 3:	**Wait for five minutes for search results (see an example of search results in Figure 1)**
STEP 4:	**Capture and convert the search result into a text file**
STEP 5:	**If there are more keywords, return to STEP 2. Otherwise, stop the search**

Fig. 3. Daily search procedure.

individual sites. Since we cannot observe what is actually being downloaded, we will utilize queue lengths only to provide an indication of system congestion across time.

To provide a baseline for comparisons, Table 3 provides observations on:

(1) average sites available for albums tracked in each of the 8 weeks of data gathering (ADFA); and,

(2) average queue length at sites available for sharing (AQLS).

As indicated in Table 3, the overall average of ADFA for each week ranged from just over 207 in week 7 to just fewer than 372 in week 2. The corresponding overall AQLS at these sites ranged from 18.60 to 19.06. Multiplying these together gives an average measure of downloading for the period analyzed. Not

Table 3
Weekly file sharing activity

Week	Group (g)	(I) Number of albums	(II) Overall average $ADFA_i(g)$	(III) Overall average $AQLS_i(g)$	(IV) (II)*(III) Total amount of sharing activity observed in searches
1	$T100_i$	98	338.20 (419.98)	18.92 (0.19)	6398.74
2	$\cup_{i\ 1}^{2} T100_i^{a}$	110	371.81 (593.72)	18.60 (0.50)	6915.67
3	$\cup_{i\ 1}^{3} T100_i$	127	319.49 (443.69)	18.65 (0.49)	5958.49
4	$\cup_{i\ 1}^{4} T100_i$	147	282.95 (333.17)	18.83 (0.63)	5327.95
5	$\cup_{i\ 1}^{5} T100_i$	163	323.60 (457.61)	18.83 (0.56)	6093.39
6	$\cup_{i\ 1}^{6} T100_i$	177	284.00 (383.55)	18.86 (0.56)	5356.24
7	$\cup_{i\ 1}^{7} T100_i$	193	207.55 (302.75)	19.04 (0.65)	3951.75
8	$\cup_{i\ 1}^{8} T100_i$	196	253.37 (407.83)	19.06 (0.60)	4829.23

Standard deviations in parentheses.

[a] $\cup_{i\ 1}^{2} T100_i$*←All albums that are ranked in the top 100 on the Billboard chart either in week 1 or 2.

unexpectedly, Table 3 indicates a large amount of sharing and downloading activity. Is the activity piracy in the legal sense? Most certainly it is. The average downloading activity observed in our daily searches of 98–196 albums ranged from over 3951 per album in week 7's searches on 193 albums (see row "7" of Table 3) to over 6915 per album in week 2's searches on 110 albums (see row "2" of Table 3). But, in a market sense, what is really happening? Is this activity, as record companies and popular writers (see Refs. [12,26], and discussion in our introduction supra) representative of lost sales? Or, is it possible that this activity includes a positive record market impact—album sampling that results in subsequent album purchase?

We begin this initial data-based investigation of these issues by considering the differences observed in sharing availability for "higher" and "lower" ranked albums across our 8-week period. As the higher ranked album set, we use grouping $T20_i$ which contains the top selling 20 albums in week i. As the lower ranked album set, we use the grouping $B20_i$ which contains the 81st to 100th best selling albums

Table 4
Sharing activity of top 20 (albums #1 #20) vs. bottom 20 (#81 #100)

Ranking week (i)	Groups (g)	ADFA			
		Second week prior ($ADFA_{i\ 2}(g)$)	First week prior ($ADFA_{i\ 1}(g)$)	First week subsequent ($ADFA_i(g)$)	Second week subsequent ($ADFA_{I+1}(g)$)
3	$T20_3$	1057.86	1369.07	682.76	514.74
		(884.71)	(1470.48)	(798.19)	(406.84)
		n 7	n 9	n 19	n 19
4	$T20_4$	1554.57	812.25	503.04	790.31
		(1643.40)	(933.14)	(442.63)	(960.52)
		n 7	n 13	n 19	n 19
5	$T20_5$	1015.5	706.61	879.37	826.29
		(980.54)	(437.94)	(982.17)	(803.75)
		n 10	n 12	n 17	n 18
6	$T20_6$	742.53	908.27	595.83	447.45
		(424.19)	(753.91)	(585.44)	(505.00)
		n 10	n 11	n 20	n 20
7	$T20_7$	920.73	702.16	447.45	613.37
		(778.82)	(659.08)	(504.22)	(828.21)
		n 10	n 14	n 20	n 20
3	$B20_3$	295.76	290.73	238.26	276.69
		(216.88)	(242.25)	(206.19)	(249.82)
		n 15	n 15	n 17	n 17
4	$B20_4$	452.77	411.99	381.62	431.24
		(501.32)	(553.30)	(452.66)	(482.53)
		n 16	n 19	n 19	n 19
5	$B20_5$	489.96	489.69	431.28	367.79
		(585.03)	(433.79)	(470.22)	(329.98)
		n 16	n 16	n 16	n 17
6	$B20_6$	452.27	470.52	298.73	299.96
		(336.55)	(461.43)	(279.52)	(445.70)
		n 10	n 14	n 16	n 16
7	$B20_7$	421.03	316.54	271.26	328.39
		(462.39)	(313.60)	(441.34)	(561.00)
		n 15	n 17	n 17	n 17
	$T20_i$ 5-week average	1058.24	899.67	621.69	638.43
	$B20_i$ 5-week average	422.36	395.89	324.23	340.81
	$B20_i/T20_i$	0.40	0.44	0.52	0.53

Standard deviations in parentheses.

in week i. Table 4 provides the relevant values. Observations in Table 4 are provided for each of the 2 weeks prior to the ranking week (i) and 2 weeks subsequent to the ranking week (i). For example, the average sharing availability for albums that were in the top 20 in week 3 was 1057.86 in week 1 and 1369.07 in week 2. The average sharing availability for albums in the top 20 in week 5 was 879.37 in week 5 and 826.29 in week 6. Note that the number of observations (n) across each row may differ across weeks. For example, in row 1, n=7 in "Second week prior", n=9 in "First week prior" and n=19 subsequently. This merely reflects the availability of those albums in the P2P network during our search process.

We find several interesting features about the data provided in Table 4. As we might expect (but which has not been previously demonstrated) the sharing opportunities for the $T20_i$ albums exceeds the sharing opportunities for the $B20_i$ albums each week with the latter ranging from 40% to 53% of the former (see last row in table). Clearly, there is a significant difference between their sharing opportunities.

Table 4 provides information on albums in specified groups for a given week. Table 5 provides sharing activity for groupings of albums that either remained in a certain grouping across 2 weeks (e.g., $T20_iT20_{i+1}$ or $B80_iB80_{i+1}D_{i+1}$) or moved to a different specified grouping (e.g., $T20_iB80_{i+1}D_{i+1}$). As noted above, the Billboard chart (posted sometime Friday or Saturday) of each week is the initiating point. Our data collection covers the following Monday, Tuesday, Wednesday and Thursday period prior to the next Billboard chart release either that next Friday or Saturday. Since some Billboard chart postings occurred Saturday evening, we decided not to include Sunday values. We did, however, double-check our results when Sunday was included and found no differences.

We note the following—in each and every case, the $ADFA_i(g)$ values are lower for the $T20_iB80_{i+1}D_{i+1}$ groupings than for the $T20_iT20_{i+1}$. That is, the average daily sharing availability is lower for albums moving from the top 20 to the bottom 80 on the Billboard chart. Of particular note is that the difference shows in the second week prior to the reported fall. It is important to remember that reported falls in the chart rankings are based on sales data while our WinMX data is based on activity related to piracy! We note the fact that the differences in sharing availability are evidenced at least 2 weeks prior to the fall in relative sales. Hence ADFA provides an accurate estimate of consumer intentions before sales data for the week is available. If the sharing/downloading activity were lost sales piracy alone, we would expect rather different outcomes—greater sharing opportunity in a week leads to a drop in ranking in subsequent week. Also of importance is that albums remaining in the top 20 grouping have higher ADFA values—more sharing availability—than albums which subsequently (2 weeks later) fall from the top 20 to the bottom 80 or drop off the chart entirely. We would argue that these observations are certainly consistent with a positive outcome—which we call "pre-purchase sampling" piracy—impact of downloading opportunities available at P2P networks such as WinMX.

The information in Table 5 provides the basis to compare ADFA for albums that fell from the top 20 with those that remained in the top 20. Delving a bit further, we thought it important to investigate the rankings/ADFA of those top 20 albums that fell with rankings/ADFA of those that remained in the top 20. Table 6 summarizes our findings. For example, higher ranked (3rd, 8th and 9th) albums in week 4 fell from the top 20 in week 5 while lower ranked (10th, 11th, 12th, 13th and 14th) ones remained in the top 20 in week 5. Even though the three "falling" albums were ranked higher in week 4, the ADFA for these albums was well below that of the lower ranked albums that remained in the top 20 on the next Billboard chart. In addition, even more lower ranked albums (15th, 16th, 17th, 19th and 20th) in week 4 that fell from the top 20 in week 5 also had ADFA values well below those that remained in the top 20. The results are consistent for all four of the comparison periods provided in Table 6 (though for week 3 to week 4, only the album ranked 7th could be utilized for the "falling" group). In each case, the ADFA for albums that fall from the top 20 are much less than the ADFA for lower ranked albums that remain in the top 20.

Another interesting observation we can draw from each case in Table 6 is that all the "falling" albums debuted in the Billboard charts only 1 week prior to

Table 5
File sharing activity and movement in rankings (week to week)

Groups (g)	ADFA			
	Second week prior ($ADFA_{i\ \ 2}(g)$)	Week prior to reported change ($ADFA_{i\ \ 1}(g)$)	During change week ($ADFA_i(g)$)	Second subsequent week ($ADFA_{i+1}(g)$)
$T20_3T20_4$	1554.57	812.25	610.54	991.00
	(1643.40)	(933.14)	(436.79)	(1098.81)
	n 7	n 13	n 13	n 13
$T20_3B80_4D_4$	719.84	402.21	307.17	325.98
	(100.64)	(256.44)	(249.80)	(292.91)
	n 2	n 6	n 6	n 6
$B80_3B80_4D_4$	339.08	283.93	297.32	334.61
	(351.50)	(339.84)	(307.47)	(332.25)
	n 63	n 73	n 73	n 73
$T20_4T20_5$	1015.5	706.61	1112.64	1037.73
	(980.53)	(437.94)	(1090.56)	(894.29)
	n 10	n 12	n 12	n 12
$T20_4B80_5D_5$	134.75	154.05	237.74	186.75
	(53.74)	(105.70)	(152.86)	(142.39)
	n 3	n 7	n 7	n 7
$B80_4B80_5D_5$	310.28	285.44	325.76	247.38
	(359.41)	(340.61)	(335.25)	(254.61)
	n 61	n 71	n 71	n 71
$T20_5T20_6$	760.48	906.83	784.64	577.84
	(445.88)	(794.68)	(692.01)	(595.94)
	n 9	n 10	n 11	n 11
$T20_5B80_6D_6$	545.00	840.14	891.75	527.11
	(455.38)	(1273.62)	(1011.96)	(484.62)
	n 3	n 7	n 7	n 7
$B80_5B80_6D_6$	287.63	300.75	246.48	218.40
	(305.31)	(302.65)	(240.30)	(307.73)
	n 60	n 69	n 69	n 69
$T20_6T20_7$	1003.52	747.90	602.25	849.88
	(778.00)	(662.46)	(562.06)	(950.45)
	n 9	n 13	n 13	n 13
$T20_6B80_7D_7$	479.67	313.39	159.96	229.68
	(626.50)	(253.91)	(165.60)	(252.86)
	n 7	n 7	n 7	n 7
$B80_6B80_7D_7$	391.75	333.98	255.63	264.51
	(530.63)	(426.47)	(323.34)	(374.03)
	n 61	n 68	n 68	n 68

Standard deviations in parentheses.
Only one album moved from B80 to T20 during our observation ($B80_6T20_7$), hence that grouping is omitted.

"falling off" the top 20. Also, only one album moved from the bottom 80 to top 20 during our observation (in week 7). These suggest heavy initial sales for albums (debut at top of chart) with rapid drop off. As indicated earlier, purchase of music is influenced by sampling experience. Our results clearly show that a high ranking is not by itself a consistent indicator of movement on the charts, and ADFA values add considerably to the predictive power of subsequent album movement on the charts.

In summary, we note three interesting aspects of the results provided in Tables 3, 4, 5 and 6:

(i) significant piracy opportunity and activity were observed (Table 3);
(ii) there is evidence suggesting "pre-purchase" or sampling piracy as well as lost-sales piracy (Tables 4, 5 and 6); and,
(iii) the observed ADFA values appear to be leading indicators of direction of movement for albums

Table 6
Movement in rankings of the Top 20 albums

Status	Rank in week *i*	ADFA			
		Second week prior ($ADFA_{i-2}$)	Week prior ($ADFA_{i-1}$)	First subsequent week ($ADFA_i$)	Second subsequent week ($ADFA_{i+1}$)
From week 3 to week 4 (i 3)					
Fell from Top 20	7	N/A[a]	343.00 (N/A)[b]	228.67 (N/A)[b]	257.00 (N/A)[b]
Stayed in Top 20	8, 9, 10 and 11	1618.84 (2186.09)	1136.687 (1386.95)	811.5 (644.90)	1134.9175 (1193.48)
Fell from Top 20	12, 15, 17, 18, 19 and 20	719.84 (100.64)	414.05 (284.87)	322.87 (275.96)	337.4717 (319.14)
From week 4 to week 5 (i 4)					
Fell from Top 20	3, 8 and 9	N/A[a]	112.84 (134.58)	177 (196.56)	221 (277.19)
Stayed in Top 20	10, 11, 12, 13 and 14	551.94 (429.23)	425.73 (346.56)	462.266 (354.50)	629.35 (537.74)
Fell from Top 20	15, 16, 17, 19 and 20	134.75 (53.74)	170.53 (105.08)	262.03 (151.02)	173.05 (101.91)
From week 5 to week 6 (i 5)					
Fell from Top 20	5, 6 and 8	N/A[a]	417.22 (172.36)	536.5 (354.83)	435.5 (249.86)
Stayed in Top 20	9, 10 and 11	1032.67 (589.01)	1571.45 (1148.51)	1453.42 (1107.47)	1262.25 (794.2)
Fell from Top 2	12, 13, 16, 18, 19 and 20	545 (455.38)	926.07 (1565.56)	933.7 (1248.79)	487.6 (607.01)
From week 6 to week 7 (i 6)					
Fell from Top 20	6 and 7	N/A[a]	103 (17.68)	122.625 (71.59)	93.75 (68.24)
Stayed in Top 20	8, 9, 10, 11 and 12	1165.134 (1018.86)	958.4 (1017.86)	772 (817.23)	737.45 (542.90)
Fell from Top 20	13, 17, 18, 19 and 20	479.67 (626.50)	397.55 (256.36)	174.9 (197.17)	284.05 (286.02)

Standard deviations in parentheses.
[a] The albums debut during the "week prior".
[b] The average is based on only one album.

in upcoming Billboard charts (Tables 5 and 6); further there is evidence that ADFA is a much better prediction of upcoming direction of sales than current chart position.

5. Pre-release activity and chart performance of new release albums

To further investigate the pre-purchase sampling piracy and leading indicator issues, we obtained upcoming release date information for 47 "new release" albums from http://www.towerrecords.com and www.cdnow.com. As soon as a release date was identified for an album, we began to track it on WinMX using the procedure described above. For each of the "new release" albums, our tracking period began at least 2 weeks prior to the actual release date of the album. Various albums are available on the sharing networks even prior to release, which are possibly sourced from promotional pre-release CDs from music companies and their marketing arms.

Table 7 provides summary information on three groupings of new releases that, during our observa-

Table 7
File sharing activity of new releases (albums)

Albums appeared on	ADFA				*n*
	Second week prior to release ($ADFA_{i-2}$)[a]	Week prior to release ($ADFA_{i-1}$)[a]	First week subsequent to release ($ADFA_i$)[a]	Second week subsequent to release ($ADFA_{i+1}$)[a]	
Top 100 on Billboard chart	282.79 (236.58)	168.29 (341.71)	343.63 (384.67)	406.00 (398.45)	3
Any Billboard specialized chart	27.69 (4.85)	25.67 (8.48)	27.81 (3.10)	40.11 (4.97)	7
Not on any Billboard chart	6.27 (6.75)	7.17 (5.57)	7.02 (5.59)	4.04 (4.59)	37

Standard deviations in parentheses.
[a] *i* release week.

tion period, appeared in the top 100 of the Billboard chart, or appeared on Billboard specialized charts, and those that did not appear on any Billboard chart. Of the 47 such albums, three appeared on the top 100 ranks of the Billboard chart and seven other appeared on other specialized charts published by Billboard, such as Rhythm and Blue/Hip Hop, Country, Heatseeker (album titles produced by new and developing artists who have previously never appeared in the top 100 of the Billboard 200 chart), and Independent (album titles that are distributed by independent record labels). We tracked these 47 albums during the November 22, 2002 to January 24, 2003 period.

The observed data from these new releases clearly suggests that ADFA is a leading indicator of sales success (Billboard chart appearance). Albums that subsequently appear on the Billboard Top 100 charts have an ADFA of 282 and 168 in the 2 weeks *before* release, while those that do not subsequently appear in any Billboard charts had an ADFA of 6 and 7 in those same weeks. (Note that "release date" and "debut date of an album on the Billboard charts" may fall on different weeks, with debut date usually a few weeks after release. We focus on release date for "new releases".) The ADFA values show similarly stark differences in the 2 weeks after release. This is an important and non-intuitive insight, and shows that ADFA can help predict album sales *even before its release*! This evidence is consistent with pre-purchase sampling piracy discussed in earlier results, and suggests that AFDA closely measures consumer interest in albums. As indicated in Section 1, radio airplay, which is a good indicator of advertising effort, is not a good a priori indicator of album sales [19]. Our results strongly suggest that ADFA may be used as a good predictor of consumer interest and subsequent sales of music albums.

We are not arguing for or against piracy. What we are doing is analyzing data on sharing availability at a popular P2P site, WinMX. The data suggests the presence of "pre-purchase sampling", an activity (sampling not piracy!) that record companies have long promoted as an effective marketing tool. Unauthorized sharing as well as downloading is, under today's statutes, piracy. Whether it leads to "lost sales" piracy or "pre-purchase sampling" piracy, the activity is piracy. But our analysis of the data suggests that the record companies might look further at this very low-cost (and by the numbers we observed—widely accessed) means of sampling, of getting the public to listen to the music. While we do not believe it is possible to eradicate piracy, we do think it appropriate to frame the following Business 101 question: *with a zero or near zero marginal cost product, are the suppliers better off with higher sales combined with piracy than with lower sales and no piracy?*

6. Lessons learned and concluding remarks

The growing popularity of online music sharing networks has attracted increasing interest on many fronts, including the music industry, consumer advocacy groups, artists and their organizations, the popular press, and government entities including state and federal legislatures. These P2P networks have become a lightning rod for debates on intellectual property rights and music market impacts. Some in the music industry have gone so far as to suggest that this issue is at the heart of the very viability and sustainability of the music business.

While the arguments, positions and policy recommendations are many, to date little has been based on observed activity on online sharing networks. The collection and analysis of data gathered from a P2P network is the foundation of our work reported here. Our data on online sharing availability were obtained from WinMX, one of the popular file-sharing P2P applications. We took particular care in ensuring that our data collection process involved neither downloading nor sharing any digital music items on our part. The relative market performance of music albums is gauged using the freely available list of top 100 albums on the weekly Billboard charts. The data gathered from WinMX is longitudinal, spanning a period of 8 weeks. In addition to gathering the online activity data on the albums that appeared on the top 100 Billboard charts, we were able to track WinMX data for 47 new albums for which we obtained upcoming release dates. For these albums, we were able to track sharing availability pre- and post-release dates. We were also able to contrast data for those albums that rose to the Billboard charts during our observation period with those that did not.

Our data analysis reveals four main findings:

(1) significant piracy opportunity and activity were observed;
(2) the level of sharing opportunities are related to albums' relative chart positions;
(3) there is evidence of both "pre-purchase sampling" piracy and "lost-sales" piracy; and,
(4) sharing activity levels provide leading indicators of the direction of movement of albums on the Billboard charts.

Significantly, these results hold both for the albums tracked subsequent to their appearance in the top 100 on a Billboard chart and for "new release" albums that we were able to identify prior to release and appearance on the chart. The former tracking involved a total of 196 albums while the latter a smaller set of 47 albums. Though preliminary in nature and covering a limited period, *it is important to emphasize that these are the first results we are aware of that are based on album specific actual observations of sharing activity together with album position and direction of move ment on the Billboard charts*. Our research provides an important and timely contribution to the crucial debate on digital products, intellectual property and sharing activity on online P2P networks. We consider key implications of our results.

Our first finding includes the significant level of sharing activity at WinMX for the albums tracked. In fact, we were able to obtain a positive search result (i.e. at least one sharer online making the music item available for sharing) for *every* album we tracked, at least once during our data collection time period. For the 196 albums that appeared in the top 100 Billboard charts and that we tracked during the data collection period, each and every one of the album searches yielded multiple such sharer files available for downloading. The same held true for the 47 new albums when the searches occurred after the public release date. In fact, 22 of the 47 albums yielded positive search results prior to their release dates! These findings suggest that the online music-sharing phenomenon is widespread and that music albums do move rapidly to the sharing networks.

Second, we observed evidence that the level of sharing opportunities online for music albums are related to their relative chart positions on the top 100 Billboard charts. In particular, we found for each of our 8 weeks of observation, that albums ranked in the top 20 of the Billboard chart in a given week had ADFA values that were greater (approximately twice) than that of albums ranked in the bottom 20 on the chart. In practical terms, a user who initiates a search for a top 20 album finds significantly more willing sharers than a user who initiates a search for a bottom 20 album. Thus, more online users share higher ranked albums than the lower ranked albums, and individuals who wish to download from these networks have more options (in terms of the number of sites from which they can choose to download from) to obtain higher ranked albums. These results clearly support potential music industry concerns about "lost-sales piracy" where users download and subsequently share popular (i.e. highly valued) music in lieu of purchasing the album through legal means.

Third, our results call attention to the likely presence of a potentially powerful offsetting type of piracy that we refer to as "pre-purchase sampling piracy". Our analysis of movements in rankings in consecutive weeks indicate ADFA levels as a positive predictor of staying power in the top 20 and a negative predictor of falling out of the top 20 during the given week. As reported in Table 5, in each and every case in both the first and second week prior, the ADFA values are significantly lower for the $T20_iB80_{i+1}D_{i+1}$ groupings than for the $T20_iT20_{i+1}$ groupings. Further, as reported in Table 6, we found that, in all applicable cases, relatively lower ranked top 20 albums that remained in the top 20 had higher sharing activity the week prior to that second ranking than did those relatively higher ranked top 20 albums that fell out of the top 20. In addition, our analysis of 47 "new release" albums revealed similar positive predictive findings, where albums that eventually rose to the top 100 on the Billboard chart had significantly higher sharing activity prior to their *release* than did the albums that never attained a position in the top 100 on the charts during our observation period. We argue that these findings point to "pre-sales sampling piracy", a phenomenon with positive benefits to record companies. Billboard charts are based on record sales while our observations are based on P2P sharing availability. If the latter is indeed a positive predictor

of the former, doesn't this suggest an effective sampling that leads to sales? In fact, we argue that this phenomenon is today's technological equivalent of the sampling that record companies sought for some 50 years ago in the days of payola.

As we suggested above, music companies may look further into this sampling as a way to get the public to listen to their music. There are various forms of sampling strategies that the music companies can implement. For example, on current file-sharing networks, there are a number of independent artists and music labels who distribute their music to consumers at no charge. The main purpose of this free distribution is to attract consumers to their web site, which might lead to subsequent purchases of other songs. Although we have not seen this practice on file-sharing networks by major music labels, the music labels routinely offer a small number of free music downloads and partial music files on regular Internet channels (i.e., web sites) to attract customers (see, for example, a free download section on http://www.amazon.com).

Finally, our results lead us to suggest an immediate practical benefit (the proverbial low-hanging fruit) to the music industry from monitoring the online sharing activity. The level of online sharing activity provides a feedback on current interest in an album and any promotional activities undertaken by the music companies. Thus it can serve as a viable decision support tool to predict upcoming chart movements. This new information can be used to help fine-tune promotional and advertising strategies for a digital hedonic product with emphasis on pushing likely winners into the grouping of real hits. We had no access to information on marketing expenditures or marketing plans for any albums and so we are relegated to conjecture. Record companies do possess, for their own albums, precise information on marketing expenditures and plans. In fact, the types of results we have reported here can serve to help these companies enhance their decision-making process and analyze the timing and impact of their marketing campaigns. For example, if the ADFA information suggests a coming fall in sales, the company may opt for early abandonment of a planned marketing campaign (cost savings) or might seek enhancement of the campaign (added expenditure) in an attempt to salvage an album. Such choices are the purview of the company's marketing experts. What analyses such as those presented here provide are informational inputs to help make better marketing decisions for hedonic products.

Other digital products that are also available on these popular file-sharing networks are not immune from the effects discussed above. Motion pictures and computer software are products with certain characteristics similar to digital music. For computer software, although producers routinely use "trial version" or "limited version" of their products as a tool to help broaden their customer base, product sampling may not necessarily result in subsequent sales without added incentives on the full version of the product. Recently, the motion picture industry has voiced concerns over file-sharing applications and high bandwidth which are increasingly available to most consumers. However, downloading a full-length movie is a relatively time-consuming process compared to music. While we acknowledge this difference, many motion picture producers make selected movie scenes available for free sampling. Monitoring the level of downloading activity of these files can potentially serve as a decision support tool similar to what we described above.

Ah, but what are results without caveats? We have emphasized that this is an initial analysis with initial results. The data is from only one P2P source, WinMX. The data is longitudinal but only covers an 8-week period. This is not to minimize the data collection effort—in fact, the data collection involved seven dedicated machines operating 24×7 and the data warehouse includes more than 2.5 MM records and 12 gigabytes of data. We are currently continuing and expanding our data collection.

In short, we suggest that the question of what underlying phenomenon drive and result in a differential sharing activity of similarly ranked (or entirely unranked) albums is interesting and worthy of further scrutiny. In general, understanding and subsequently benefiting from this phenomenon has wide regulatory and marketing implications for other digitized hedonic products, and particularly for the overall entertainment industry. With the data currently at our disposal, we cannot ascertain which of the phenomenon, "lost-sales" piracy or "pre-purchase sampling" piracy, dominates nor can we determine the overall economic impact of P2P networks on the music industry. Our findings, however, do suggest that the

initiatives aimed at shutting down the operations of these P2P on-line sharing networks would have a "throwing the baby out with the bathwater" effect. Strategies that help foster the pre-purchase sampling and advertising aspects of online sharing networks, while minimizing the lost-sales effects, will enable the music industry to better leverage the information technologies in the new era of increasing digitization of the music product.

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