The Economics of Internet Radio

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I. Introduction

In the euphoria over rapidly improving Internet and multimedia delivery technologies in the late 1990's, webcasting was touted by many as a technology that would revolutionize the entertainment world, and it was forecast that audio webcasting services would soon be a major threat to over-the-air radio stations. The actual experience has fallen considerably short of these optimistic projections. Although audience size has increased significantly, advertisers have not embraced this new medium as anticipated. Furthermore, while costs have declined remarkably, they are not near low enough for profitability given the ad revenues the new services have been generating, or can expected to generate for at least the near future. Partly as a result, thousands of Internet radio stations have gone off-line since April 2001, including both top stations and unheard-of small webcasters[1].

This paper examines the economics of radio-like webcasting services (hereafter referred to as Internet radio services or simply Internet radio) using over-the-air (OTA) radio as a standard of comparison. The comparison with OTA serves two purposes. First, Internet radio was and still is seen by many as an on-line substitute for OTA radio and a potentially serious competitor for the OTA audience. Comparing OTA and Internet radio may provide insights into factors affecting the competition between other online information and entertainment services and their closest off-line counterparts. Second, the widely-used and publicly-available sources of data for OTA audiences, revenues, and

[1] The Librarian of Congress' decision on fees was also important, but stations were going off-line in large numbers long before the decision was handed down. (Commercial webcasters need to pay a $0.0007 per

ad prices can be sued to assess the commercial potential of Internet radio. There is no equivalent source of revenue and ad rate data for Internet radio, but we can apply OTA ad rates to on-line audiences to construct one measure of the revenue potential of on-line audiences.

The paper is organized as follows. Section II defines Internet radio as the term is employed for this study and distinguishes it from other Internet audio services. Section III provides comparisons of OTA radio revenues and costs to various measures of Internet radio revenues and costs. Section IV presents a simple model that suggests that as long as Internet radio services reach a significantly smaller fraction of the aggregate audience for radio-like services, they will have to charge lower per listener rates to advertisers—unless their listeners largely stop listening to OTA stations. Section V discusses the likely impact of streaming costs on programming strategies.

II. Defining Internet Radio

Internet radio is a radio-like service transmitted over the Internet. From the user's perspective, the experience is similar to OTA radio. Programming may be pre-recorded voice tracks simulcast by an OTA broadcaster or real time playback on a remote server with varying degrees of interactivity, but listeners must "tune-in" to receive a webcaster's programming—which is delivered through streaming technology (see Section III) and generally cannot be downloaded[2].

Internet radio shares the characteristic of all online streaming multimedia content that costs increase with the rate at which data is delivered to users. For constructing cost

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performance royalty to copyright owners for digital sound recording, which their over-the-air counterparts are exempted from. http://www.copyright.gov/carp/webcasting_rates_final.html)

estimates, however, it has the dual advantages of relatively low variability in bandwidth demands and compared to video services, a relatively low bandwidth requirement for an acceptable quality service. The result is a comparatively simple cost structure. Thanks to the relatively low bandwidth requirement, Internet radio stations can meet most listeners' needs by providing two bandwidth options (often 22Kbps and 100Kbps), but the same cannot be said about other types of streamed content such as video, which often needs to offer several bandwidth options to serve users with different connection speeds. The attributes of the content may influence data volume and costs remarkably. For example, a hockey game inevitably requires frequent zoom-ins and zoom-outs to catch the fast movement of the puck and the teamwork of the players, producing high variability in data transmission rates. By contrast, a constant 100Kbps connection will provide acceptable quality for audio tracks.

Due to varied applications of Internet technology, there is often confusion among different services using the same technology. The first concerns different online music services. The legal definition[3] and underlying technology used for Internet radio makes it distinct from other online music services, ranging from the subscription services from major music labels (eg. MusicNet and PressPlay, which provide mixed product of streaming and downloading) to file-swapping networks (such as Gnutella and Kazaa, which provides downloading of video/audio files.) The biggest difference between the economics of Internet radio and subscription-based online music services is that the

[2] There are some ripper programs that allow users to download streamed content, but generally speaking they require of computer skills that exceed the capabilities of most users.
[3] The language in DMCA (Digital Millennium Copyright Act) is rather complicated, but basically it draws a line between Internet radio and subscription services by making non-subscription/non-interactive services (Internet radio is one of these) and subscription or interactive services subject to different royalty setting processes or proceedings.

subscription-based online music services are financed through user fees and are accessible only to subscribers, while Internet radio services are available free to anyone with a browser and a media player and are supported by revenues from selling access to their audiences to advertisers. Also, from a service provider's point of view, the technology costs are much less with downloading than for streaming services. Technology costs are lower still for file swapping services, and these services provide no radio-like programming.

III. Comparing Revenues and Costs for OTA Radio and Internet Radio

A. Comparing Technologies for Webcasting and Broadcasting

In comparing Internet radio and OTA radio costs, we consider only the personnel and technology costs attributable to transmitting programming to listeners. The technology costs of delivering webcast programming basically consist of the cost of digitizing the requested content and serving the content from the webcaster's streaming media servers[4] to the Internet user requesting that content. From the viewpoint of a webcaster making an investment decision, three alternative technical models for providing a service must be considered: (1) Pure in-house streaming, where all equipment and personnel are supplied by the webcaster who also procures transport services from bandwidth suppliers. (2) Co-located streaming, where a webcaster operates its own equipment employing its own personnel, but the equipment is located on the premises of a provider of network services. (3) Outsourced streaming, where a webcaster provides content and contracts with a content delivery network for various content management services and all technical and network services associated with streaming.

The different models of network setup produce different cost structures and different levels of operational flexibility. Table 1 summarizes the operational considerations for each solution. See Appendix I (available on request) for a detailed discussion.

Table 1 Comparison of operational characteristics of webcasting models

Operational characteristics	Pure in-house streaming	Co-located streaming	Outsourced streaming
Control over network usage in webcasting center[5]	High	Medium	Low
Certainty of quality control over content delivery outside of webcasting center[6]	Low	Medium	Medium
Efficiency in bandwidth utilization	Low	High	High
Flexibility in adjusting costs and number of streams	Low	High	High
Required level of technical expertise	High	Medium	Low

In addition to these complications, webcasting is also fundamentally distinct from traditional broadcasting in the network transportation aspect (Figure 1, also see Appendix

[4] Usually a hardware server running a streaming server software application from one of the three major technology providers: RealNetworks, Microsoft and Apple.

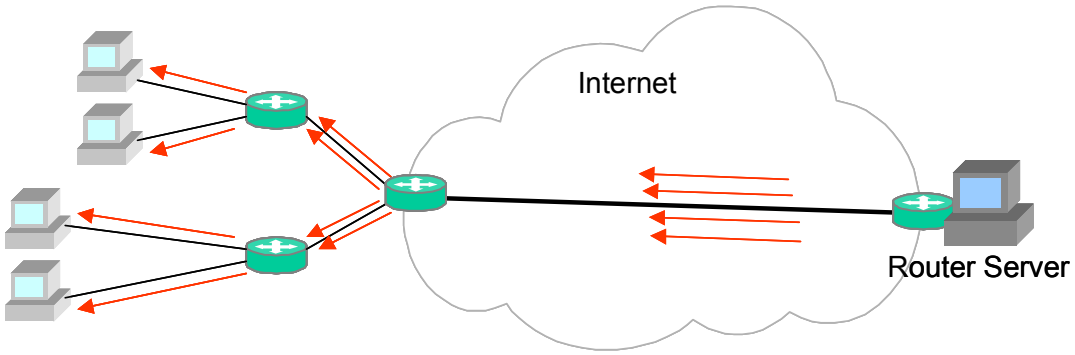
[5] Webcasters implementing pure in-house streaming have greatest control over the network usage (how bandwidth should be allocated among servers, how the network should be configured, etc.) of the webcasting center as they build it on their own site. The more they out-source this task to an outside supplier, the less control they have over the network usage in the webcasting center. However, pure in-house streaming does not offer control over the entire transmission processes. Some large co-location and out-sourced streaming service providers have built their own backbone network and can have better control over the quality of the delivery network. In these cases, webcasters have more control over the overall network usage.

[6] Pure in-house streaming does not offer control over the entire transmission processes. Once the stream is out of the webcaster's webcasting center, the webcaster loses control over the delivery of the stream. On

II for details.) The point-to-point structure depicted in Figure 1 shows that requests for the same programming result in duplication of data streams and cause backbone bandwidth consumption to increase in proportion to the number of requests. This explains why the technology cost of distributing the programming increases with the number of listeners or viewers reached. The picture for OTA broadcasting is much simpler, because the distribution costs for an OTA broadcaster do not vary with the number of people tuning into its signal.

While contributing to the high incremental costs, the point-to-point characteristic is a mixed blessing in that it also allows for higher interactivity, which might be used to help service providers and advertisers better profile their listeners and serve them with more tightly targeted ads, leading to higher ad efficiencies, and potentially higher ad revenues.

Figure 1 A unicast Network



Unicast

Many webcasters provide synchronized links on the media player so listeners can get artist/album information and lyrics when they hear a song they like. They can also join discussion groups for certain artists or music genres by clicking the links provided by the

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the other hand, many large co-location and out-sourced streaming service providers have built their own

webcasters. And since each connection is independent of the others, it is also technically feasible for listeners to skip songs, to rate songs and decide how frequently they would like to hear certain songs in the future. This allows listeners to listen and surf in a more active way, but the legality of this type of interactivity for non-subscription services under the DMCA is currently a matter of dispute.

B. Cost Analysis

For our purpose of analyzing the technology characteristics and the corresponding constraints imposed on webcasting, we focus on technology distribution costs and assume other costs, such as production of programming, sales and marketing, administration, overhead, etc. are the same for webcasters and broadcasters with the same sizes of audience. We sort Internet radio's technology distribution costs into three principal cost components: streaming equipment (hardware/software /networking gear), technical personnel, and transmission costs. More information about the cost components can be found in Appendix III (Available on request.)

Quite a few variables might cause costs to vary widely. Trade-offs can be made between costs and quality (data processing quality, transmission quality, system downtime, etc.), also, significant price dispersion with respect to various suppliers, geographical market, individual conditions (such as longer distance between company site and the data center of network service providers) and traffic patterns[7] can be observed for all three technology cost components. We cope with this cost variability by

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backbone network and can have better control over the quality of the delivery network.

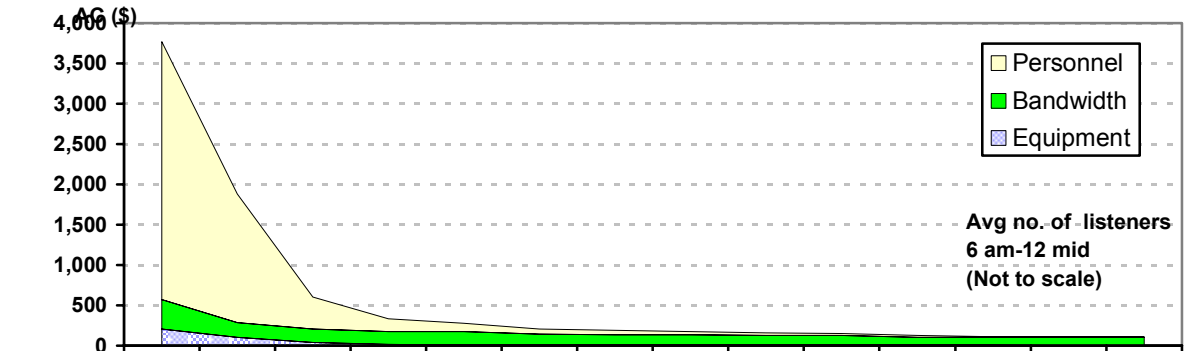
[7] For example, for a webcaster with a spiky traffic pattern, say, 50% of its traffic occurs between 10 a.m. and 1 p.m., it might need to preserve a large bandwidth for those peak hours, and during off-peak hours the bandwidth will be under-utilized. The cost for such a webcaster will be very different from one with similar monthly data volume but with even traffic throughout the day.

calculating costs for two representative webcasters for each technology model, one operating with a shoestring setup (low-end case), the other using high-end equipment and services. The intent is that the two estimates will bracket the range of actual costs in the industry. The approach also reveals cost characteristics that are not contingent on specific choices Internet radio services make among technology options. (Details about these sources of variability and how we tackle these problems can be found in Appendix IV.)

Figures 2-4 show how average technology cost per listener varies with the number of listeners (measured in average quarter hour persons, or AQH[8]) for webcasters adopting different models of network setup. These are data of hypothetical webcasters using low-end equipment/services for their network setup. Appendix IV describes cases for which high-end equipment/services are employed. The basic shapes of the cost functions are the same for high-end and low-end solutions.

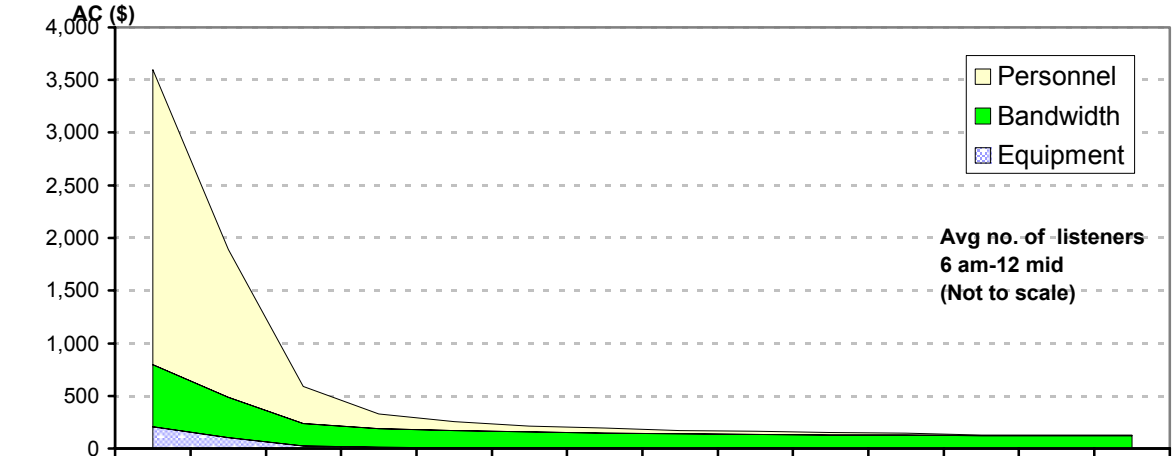
[8] AQH (average quarter hour persons) is the estimated average number of persons listening to a station for at least 5 minutes during any quarter hour in a specific time period. Arbitron and MeasureCast, the only two webcasting auditors, usually release data only on ATH (aggregate tuning hours), which measures the aggregate hours of streaming lasting more than five minutes during the period of measurement. We derive AQH data by dividing ATH numbers by 18*30, based on the assumption that the traffic to a webcasting service usually occurs between 6 a.m. and 12 midnight. Although not measured in the same way OTA radio is (using panel data), this is the most common industry practice for translating ATH into AQH for cross-service comparisons.

Figure 2 Average distribution technology cost vs. number of streams for pure in-house streaming



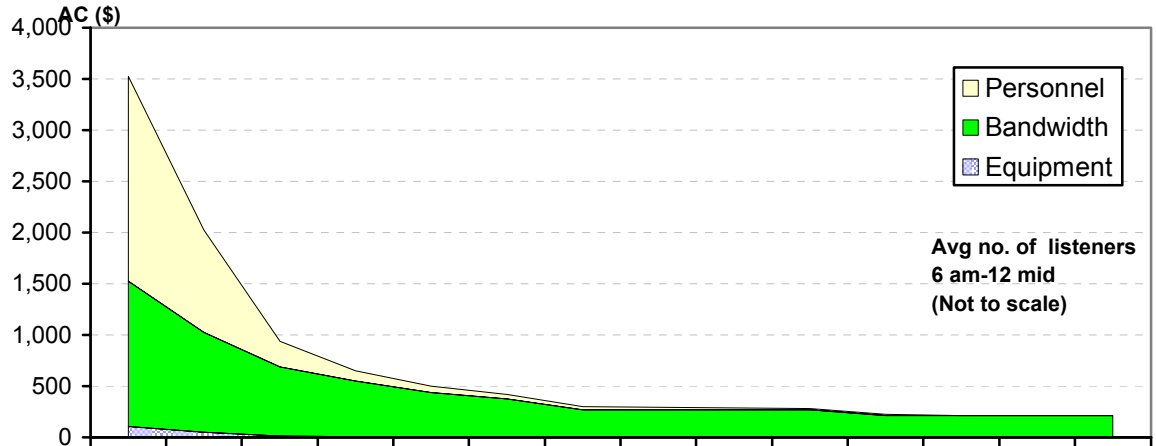
	25	50	200	500	800	1,200	1,600	2,000	2,400	3,000	5,000	10,000	15,000	20,000
Personnel	3,200	1,600	400	160	100	67	50	40	33	27	18	9	9	7
Bandwidth	364	182	166	157	167	132	128	128	119	117	101	101	100	100
Equipment	208	104	43	18	11	11	11	11	12	10	7	6	5	4

Figure 3 Average distribution technology cost vs. number of streams for co-located streaming



	25	50	200	500	800	1,200	1,600	2,000	2,400	3,000	5,000	10,000	15,000	20,000
Personnel	2,800	1,400	350	140	88	58	44	35	29	23	16	8	8	6
Bandwidth	591	385	213	177	164	151	144	135	130	128	127	119	119	118
Equipment	208	104	26	11	7	7	5	4	5	4	4	3	3	3

Figure 4 Average distribution technology cost vs. number of streams for outsourced streaming



	25	50	200	500	800	1,200	1,600	2,000	2,400	3,000	5,000	10,000	15,000	20,000
Personnel	2,000	1,000	250	100	63	42	31	25	21	17	10	5	3	3
Bandwidth	1,419	973	678	546	433	377	269	268	267	267	213	212	212	211
Equipment	108	54	14	5	3	2	2	1	1	1	1	0	0	0

The following points can be made based on our cost analysis:

1. Bandwidth is the dominant cost component. Although bandwidth cost is undergoing rapid decline, the cost burden is far from negligible. Our cost estimates suggest that $100 annual transmission cost per AQH person is common place even for established webcasters (with AQH over 250, which might rank 26 in Arbitron's April 2002 channel ratings), and many webcasters are paying well above $100 annually for per AQH person, personnel and equipment costs not included.

2. Due to volume discounts and spreading fixed costs over greater volumes, economies of scale can be observed in all settings.

3. Outsourced streaming services considerably reduce the initial entry cost of webcasting, since almost all the fixed costs are absorbed by the service providers and averaged over the aggregated volumes.

4. In general, the technology costs of hiring outsourced streaming services are more than pure in-house and co-located streaming. However, this is not an apples-to-apples comparison, since the difference partially stems from the valued-added services (content delivery and management, which provides better quality control, traffic

reports, etc.) provided by the out-sourced streaming service providers on top of standard network transmission services.

The corresponding costs for OTA radio are much easier to describe. We use as benchmarks the costs of engineering personnel, tower, antenna and transmitter for class A and class C FM radio stations as reported in Appendix VI, with equipment costs expensed over a 10 year period, assuming a 10 percent discount rate.

C. Revenue Analysis

Although not the sole source of revenue for Internet radio, advertising is by far the dominant source and the one webcasters have counted on most. Thus we focus on advertising revenues for our analysis. We begin by calculating the advertising revenues Internet radio audiences would generate if they commanded the same per listener prices advertisers pay for access to OTA radio audiences. These types of "what-if" calculations were the inspiration for many of the Internet radio ventures. We use them here as a measure of the revenue potential for Internet radio, but also as a benchmark for evaluating the revenues actually generated.

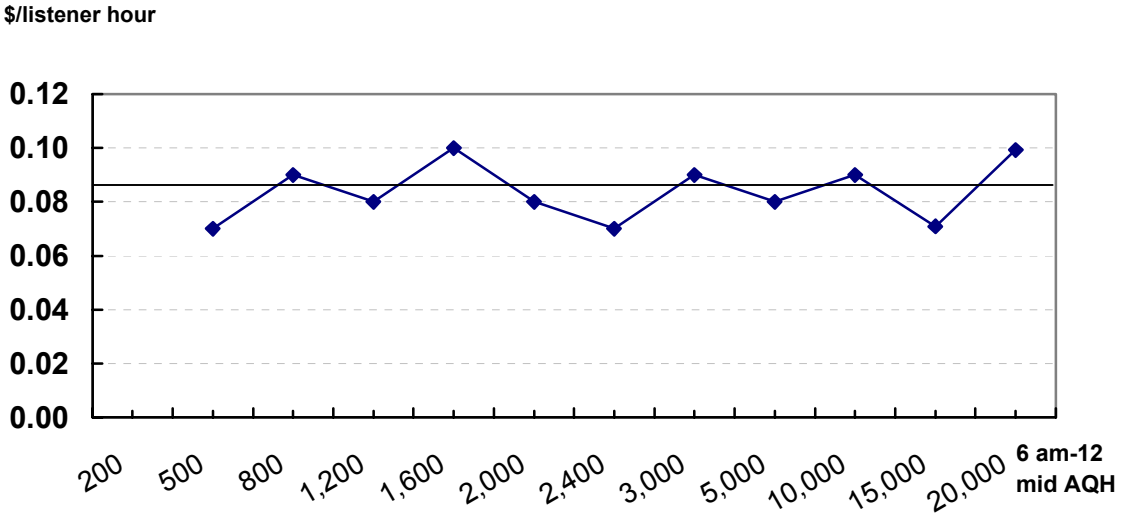
Figure 5 (see Appendix VI for details) presents out calculations of average revenue per listener-hour for stations with different sizes (measured by AQH[9]) based on data reported by Duncan Radio for 2001[10]. There is no apparent trend in the audience size-

[9] See note 8.

[10] In computing these average data for stations with different audience size, we collect data from stations whose size falls within ±10% of the point of interest and average these data. (For example, we average data for stations with AQH between 900 and 1,100 to get the average data for a representative station with 1,000 AQH.) It is noteworthy that there are great variations in individual data of revenue per listener hour and no clear trend is observed, this is consistent with the known facts in the industry ("Who Should Set the Prices for Radio Spots?", Radio Business Report)

revenue per listener hour relationship and we use the average[11], $0.0868/listener-hour, to calculate the projected advertising "what-if" revenues for webcasters shown in Table 2[12].

Figure 5 Average revenue per listener-hour for OTA radio stations



Source: Duncan's Radio Market Guide 2001, Station Tracking And Rating Service of Duncan Radio

Comparing revenue data released in companies' annual reports and fillings to Copyright Office to these projected revenue shows applying OTA revenue per listener-hour to Internet radio is likely to substantially over-estimate the actual revenues. We have access to eight webcasters' 2001 revenue and AQH data; and these generate revenue per listener-hour figures ranging from $0.00005 to $0.0095, much lower than the $0.0868 per listener-hour derived from OTA radio data. A look at Netradio.com historic sales data might give this notion further support. Until its shutdown in October, 2001, Netradio.com usually topped Arbitron's webcasting network chart, totaling about 10,000 AQH, but even at its peak (2000, when the dot-com bubble had not yet completely burst)

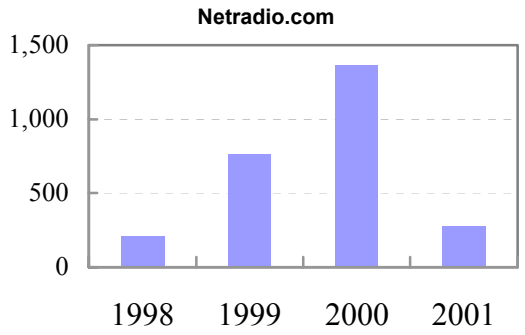
[11] The coefficient on AQH from running a regression of revenue/listener-hour on AQH is statistically insignificant.
[12] Based on the widely-used assumption made by radio professionals that most of the traffic occurs between 6 am to 12 midnight.

it only brought in less than $1.5 million a year; and the revenue per listener-hour for its fourth quarter of 2000 was only $0.0288. Even with revenue per listener-hour of $0.0288, it still could not have the projected $6 million revenue that an OTA station of comparable audience size would make.

Table 2 Projected Internet radio advertising revenues

Avg. 6am-midnight AQH	Annual Revenue ($)
25	14,257
50	28,514
200	114,055
500	285,138
800	456,221
1,200	684,331
1,600	912,442
2,000	1,140,552
2,400	1,368,662
3,000	1,710,828
5,000	2,851,380
10,000	5,702,760
15,000	8,554,140
20,000	11,405,520

Figure 6 Historic advertising revenue data of Netradio.[13]



Source: Company filings to SEC

[13] Netradio.com's 2001 revenue only includes the first three quarters as it shut down in October.

D. Revenue and Cost Comparisons: Internet Radio vs. OTA Radio

Revenue and cost comparisons for OTA and Internet radio show Internet radio to be at a considerable disadvantage on both counts. Table 3 compares average distribution costs to average revenues for Internet radio services applying the average price paid for OTA audiences reported above. At current cost levels, the picture that emerges is not an optimistic one.

Table 3 Ratio of average distribution costs to average revenue

6 a.m. to 12 a.m. AQH	% In-house	% Collocation	% CDN
25	661.43	631.10	618.42
50	330.72	327.06	355.44
200	106.66	99.23	165.15
500	58.75	53.51	114.15
800	48.82	41.25	87.52
1,200	36.89	33.82	73.76
1,600	33.08	29.68	53.01
2,000	31.37	26.46	51.65
2,400	28.91	24.57	50.75
3,000	26.87	23.19	49.85
5,000	22.02	21.63	39.16
10,000	20.20	18.74	38.07
15,000	20.06	18.70	37.71
20,000	19.58	18.29	37.53

We have access to eight webcasters' 2001 revenue and AQH data; and we take the five most favorable to construct an optimistic range for revenue per listener hour possibilities based on known revenues generated by webcasters. This range is superimposed on the corresponding range for our cost estimates in Figure 7. Similarly, Figure 8 depicts the corresponding relationship between cost and revenue for OTA radio.

Figure 7 Costs and revenues for Internet radio

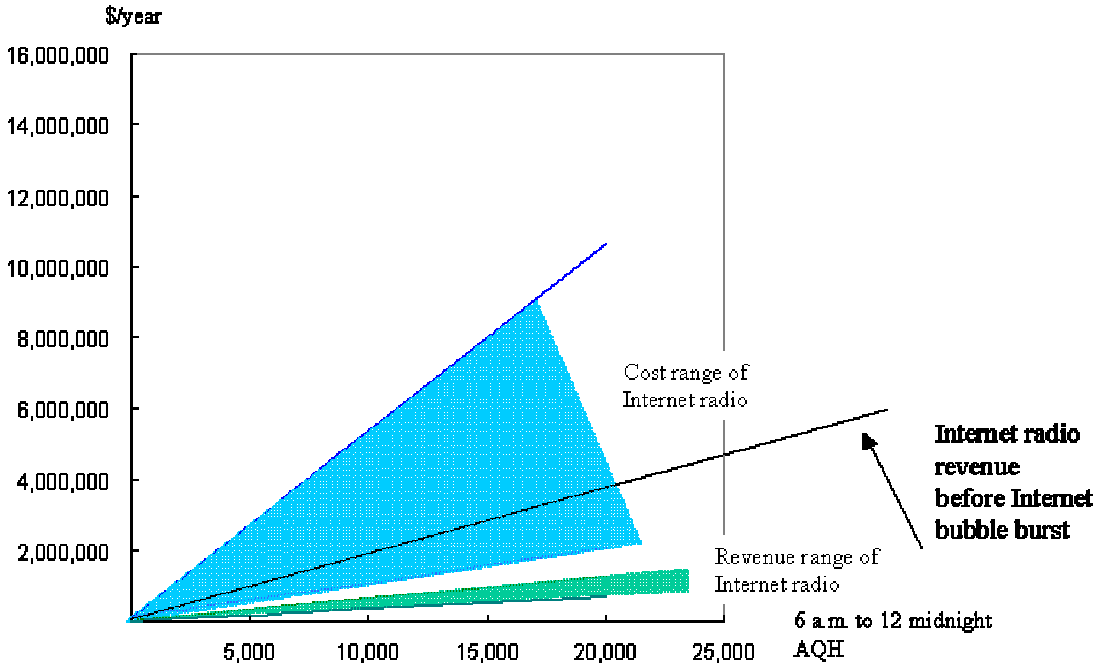


Figure 8 Costs and revenues for OTA radio

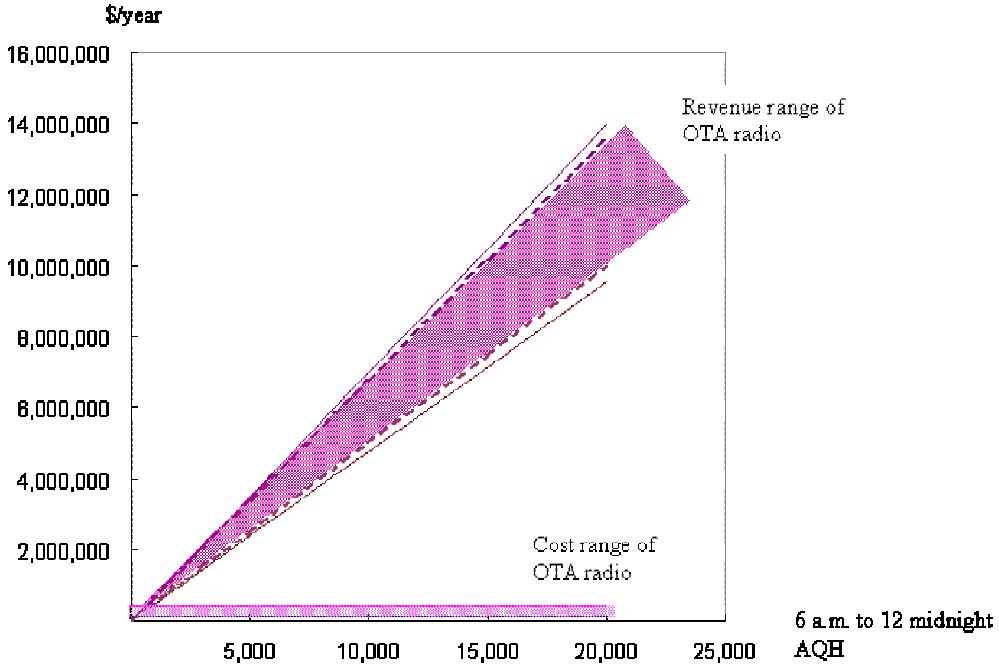
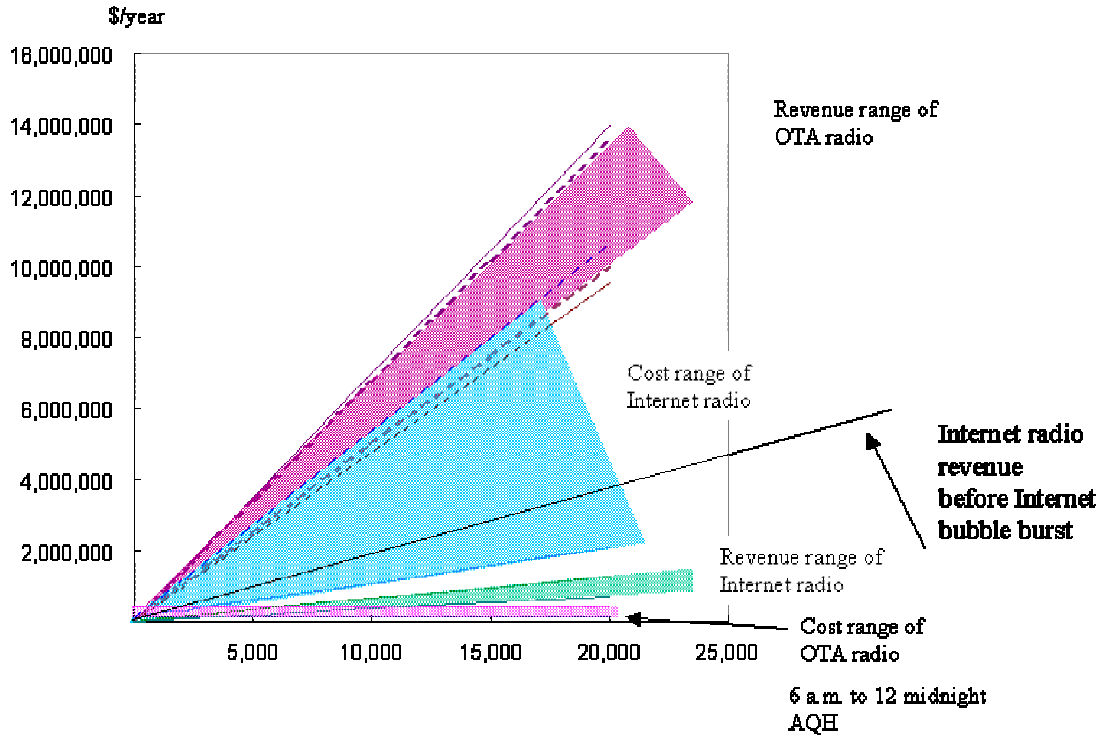


Figure 9 combines Figures 7 and 8 to more directly compare the cost and revenue of OTA and Internet radio.

Comparing the costs and revenues of Internet and OTA radio shows that under current cost structures, Internet radio stations operate at a considerable cost and revenue handicap to OTA stations, even if we ignore their considerably smaller audiences.

Figure 9 Costs and revenues for Internet and OTA radio



Source: Duncan's Radio Market Guide, Duncan's Station Tracking and Rating Service, http://www.ntia.doc.gov/ptfp/application/equipcost_Radio.html

IV. A Model of OTA and Internet radio Pricing

Internet radio is not alone among web-based media in suffering from lower than anticipated advertising revenues. Following an initial euphoria over the prospects for advertising on the new medium, there has been a noticeable fall-off in demand for Internet ads in general. Part of this decline can be attributed to the collapse of the dot-com sector of the economy starting in mid-2000. Dot-coms were big buyers of Internet ads during the Internet bubble, and this advertising has largely dried up as many of these firms have either gone out of business, or dramatically curtailed their operations and expenditures, including advertising. But even outside the new economy sector, the fall-off in enthusiasm for Internet advertising is quite noticeable.

A number of reasons have been given for more traditional advertisers' reduced interest in Internet advertising vehicles—reasons that would apply to the remaining new economy firms as well. One is that advertisers are waiting for more compelling evidence that the banner ads, streamers, and pop-ups that are the staples of Internet advertising can be effective in boosting the sales of their sponsors' products. (Kranhold, 2000; Streitfeld, 2000; Lefton, 2001; Graham, 2002) This is not to say that there are no examples of success, or that research has not pointed to ways in which these types of advertising vehicles might potentially be used effectively (Barwise, Elberse and Hammond, 2002), only that there is still considerable uncertainty about the appropriate role of Internet ads in an ad campaign. To date, Internet radio services, like other Internet-based advertising vehicles, have relied primarily on advertisements placed on the website accessed to access their audio streams. By contrast, OTA radio sells within-program commercial

time, which has the advantage of being more difficult to ignore than display ads positioned around primary content on a website. It would seem natural for Internet radio services to turn to in-program ads themselves, and, with developments in in-stream insertion technology, some Internet radio services have started to sell in-program commercials.

Audience measurement has also been an issue for Internet advertising. Audiences for Internet radio services are too small to make the use of diaries and/or meters employed to estimate the audiences for OTA radio stations and television cost effective for measuring Internet radio audiences due. Diary and meter measurements rely on intensive record-keeping by small samples of listeners, with samples constructed to be demographically representative of the radio audience as a whole. Because Internet radio audiences are so small compared to OTA station audiences, traditional sample sizes would not yield statistically reliable audience estimates and expanding sample sizes would entail costs that could not be justified by the current revenue prospects of the medium. On the other hand, the services providing estimates of Internet radio audiences rely on server logs to learn about individual users' listening behavior. Server logs can provide accurate information about when a listener tunes in, and how long she continues to stream a station and when she switches to another channel provided by the same webcaster through the same web server. These services also combine server records with panel data so that demographic information for audiences can also be obtained. However, the audience measurement services currently cannot verify the extent to which their demographic samples are representative of the Internet user population as a whole. Furthermore, because not all Internet radio services participate, it is not possible to

construct the types of audience share measurements reported by Arbitron for OTA radio audiences.

Internet audience measurement methodologies are new and it is fair to say that advertisers (and the services themselves) are still in the process of learning exactly how these measurements translate into value for advertisers, and how they compare to the analogous measures for OTA radio. The bottom line is that advertisers do not have the same level of comfort with available measures of Internet radio audiences that they have for OTA radio audiences, which makes Internet radio ad buys look like a riskier proposition. If advertisers are risk averse, this greater perceived risk should be reflected in a lower price for access to Internet radio audiences than to OTA radio audiences.

The audience measurement problems currently plaguing Internet radio are the types of problems one would expect for any new ad-supported medium. Each medium poses different challenges for audience measurement, and for each established medium these challenges were addressed over time as the industry grew and matured.[14] Some of these problems will be overcome by the types of innovations and incremental improvements that can be expected to occur naturally for any new service over time. However, others may require a commitment of financial resources that can be justified by the audiences and revenues that only a more mature industry can deliver. Cable networks suffered from an audience measurement handicap for years in their competition for advertising dollars with broadcast networks because cable audiences were too small for accurate measurement with household samples of the size used to measure broadcast

[14] Developments in audience measurement technology for several media are described in Napoli (forthcoming).

network audiences. This is one explanation for why the audiences sold to advertisers by cable networks have traditionally sold at a considerable discount to audiences sold by broadcast networks.

However, now that their audiences are included in the audience measurement reports of Nielsen (the major television audience measurement service), cable audiences still sell for less on a per viewer basis than do broadcast audiences. Waterman and Yan (1999) provide data for the 1997-1998 television season showing that, with some variation across dayparts and audience sub-segments, cable network CPMs (price per thousand viewers) were commonly less than half of the CPMs for the major broadcast networks.[15] Because there is still a substantial minority of viewers that can be reached only via OTA signals, and cable networks' coverage of the cable universe is typically less than 100 percent, cable networks reach a smaller fraction of television households than do broadcast networks.

Waterman and Yan showed that for a sample of 18 of the largest cable networks, CPMs increased with the number of households. Based on their regression coefficients, they suggested that the cable CPM disadvantage relative to broadcast networks would disappear if cable networks achieved coverage of television households comparable to the near 100% level realized by the broadcast networks, and, due to the advantages of being able to sell access to the more narrowly targeted audiences attracted by special

[15] The major broadcast networks are ABC, CBS, NBC, and Fox. Fox data was included only in the prime time audience CPM measurement for the major broadcast networks. There is some ambiguity as to how to compare prime time cable CPMs to broadcast network prime time CPMs. Waterman and Yan report a broadcast network prime time CPM of $11.85. Cable CPMs reported are $8.75 for "Prime Upscale" audiences and $5.25 for "Prime Mass" audiences, which would seem to correspond most closely to the broadcast networks' audiences.

interest cable programs, cable CPMs could actually exceed those for the broadcast networks.

In their competition with OTA radio stations for a share of radio advertising dollars, Internet radio services are in a position similar to that of cable networks competing with broadcasters for television ad dollars. Everyone listens to OTA radio and, while the Internet radio audience is growing, it will be many years before its audience coverage approaches that of its OTA counterpart. The remainder of this section examines in more detail the economics of the relationship between coverage and the price at which audiences are sold. The analysis that follows shows that a coverage handicap alone is not sufficient to generate the types of price per audience member disparities observed in the prices paid for broadcast and cable ad time. Rather, what is required is that members of the audience for the service with lower coverage also show up in the audience for the service with higher coverage. The implication for Internet radio is that as long as it continues to reach a substantially smaller portion of the aggregate radio audience than OTA radio and its listeners continue to listen to OTA stations, it can expect to sell access to its listeners at a discount to prices charged by OTA stations.

We start with the assumption that, for an advertiser purchasing radio ad time, different listeners are not viewed as substitutes for each other even if they are demographically identical. Therefore, if access to two different listeners must be purchased from different radio services, two different prices could be paid. Then, taking the price for access to OTA-only listeners as given, we ask how access to Internet radio listeners, who are assumed to show up in both the OTA audience and the Internet radio audience, is likely to be priced.

While it has been argued that the "law of one price" should apply to television viewers if demographic characteristics are held constant (see, especially, Fournier and Martin, 1983), Waterman and Yan (1999) show that CPMs vary with coverage for cable networks even after controlling for differences in demographic composition in these networks' audiences, and Wildman and Cameron (1989) found CPM differences for radio stations that were correlated with coverage after controlling for format. Wildman, McCullough and Kieshnick (2001) also provide evidence that cable subscribers and broadcast-only viewers within the audiences for broadcast network programs sell at different implicit prices. The reason why different listeners should not be viewed as substitutes for each other by advertisers is that each listener can make an independent contribution to an advertiser's profits by buying its product. (Wildman, 1998) Unless the advertiser's profit margin on a sale made to consumer B is influenced by a sale made to consumer A, the price paid for the opportunity to reach A by one media vehicle should not affect how much the advertiser is willing to pay to reach B through another vehicle. Or, if A and B are two listeners in the audience for a single radio service, it is possible that the implicit price charged the advertiser for access to them might differ, perhaps because the alternative options available to the advertiser for reaching them differ, as Wildman, McCullough and Kiesnick found for cable and broadcast-only viewers of broadcast networks' programs. (They also present a formal model that demonstrates that this type of relationship is to be expected.)

In purchasing ad time from a radio service, whether a radio station or an Internet radio service (and in purchasing ad space on the latter's website), an advertiser is purchasing the chance to present its advertising message to listeners in the audience at the

times its ads are aired. The total audience reached by a radio service of either type over time will always be bigger than the number of listeners in its audience at any given time because no listener listens all the time, and members of the aggregate audience reached will tune in and tune out at different times. In terms of the advertiser's goal of reaching members of a radio service's aggregate audience, this means that the probability of reaching any individual member of that audience with any specific play of its ad will be less than one. However, with repeated plays of the ad, the likelihood of reaching that listener increases. It is easy to show that this probability increases at a decreasing rate. So on probabilistic grounds alone the marginal value of ad units to an advertiser should decline. This is true whether a radio service's audience listens only to that service, or if listeners to the service also listen to other services where the ad also plays. (Wildman, McCullough, and Kieshnick, 2001). If the contribution an exposure to an ad for a product makes to a listener's likelihood of purchase declines with the number of exposures, then this would be a second reason to expect the marginal value of ad time to fall, and an advertiser's demand for ad time to be downward sloping, because the likelihood that any individual listener will be exposed to an ad more than once will increase with the frequency with which the ad is aired.

Finally, note that if all the advertiser cares about is the number of times a potential customer is exposed to its ads, for potential customers that consume multiple media products, exposure to an ad on one service does reduce the value of an exposure on another service, so that ads aired on one of the services reduce (but not to zero) the contribution an ad on one of the other services used by these consumers makes to the likelihood that that they will be exposed to the advertiser's ad. So audience overlap does

create interdependency in the pricing of access to the common members of different media services' audiences.

Now consider an advertiser's demand for ad time on a specific radio station. The advertiser's demand curve for access to one of the station's listener's who does not listen to Internet radio services is shown in Figure 10. The per listener price charged for access to the station's OTA-only audience is P_r, which corresponds to a_r units of ad time. How this price is set is not material to this analysis.[16] Suppose that OTA-only listeners in the station's audience spend H percent of their time listening to the station, and that Internet-radio listeners in the station's audience spend h percent of their time listening to an Internet radio service with programming similar to that on the OTA station and H-dh of their time listening to the OTA station. d is the rate at which on-line listening substitutes for OTA listening. Presumably, $0<d<1$.

[16] This is modeled in Wildman, McCullough and Kieshnick (2001).

Figure 10. Per listener ad price for an OTA-only listener

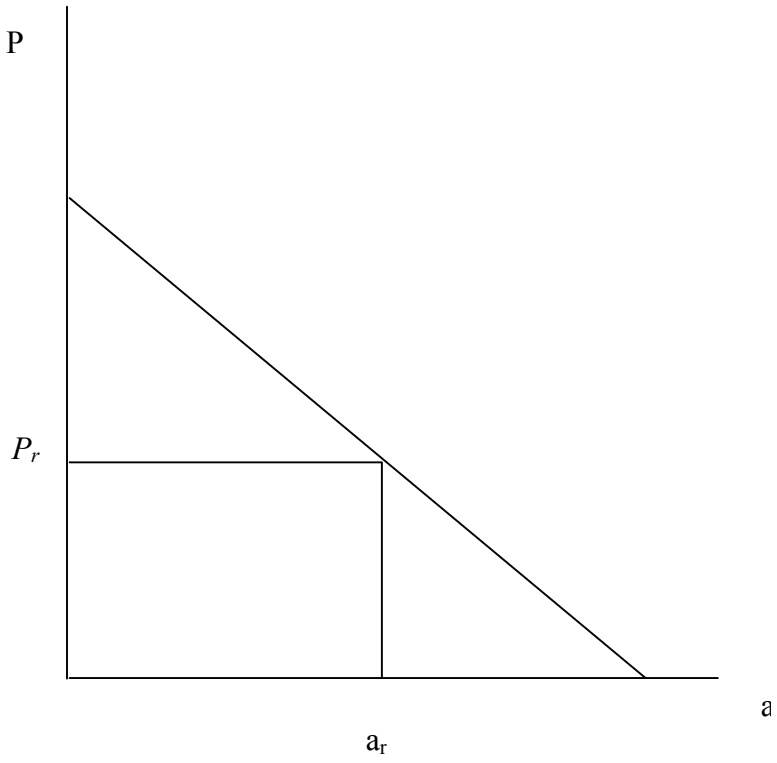
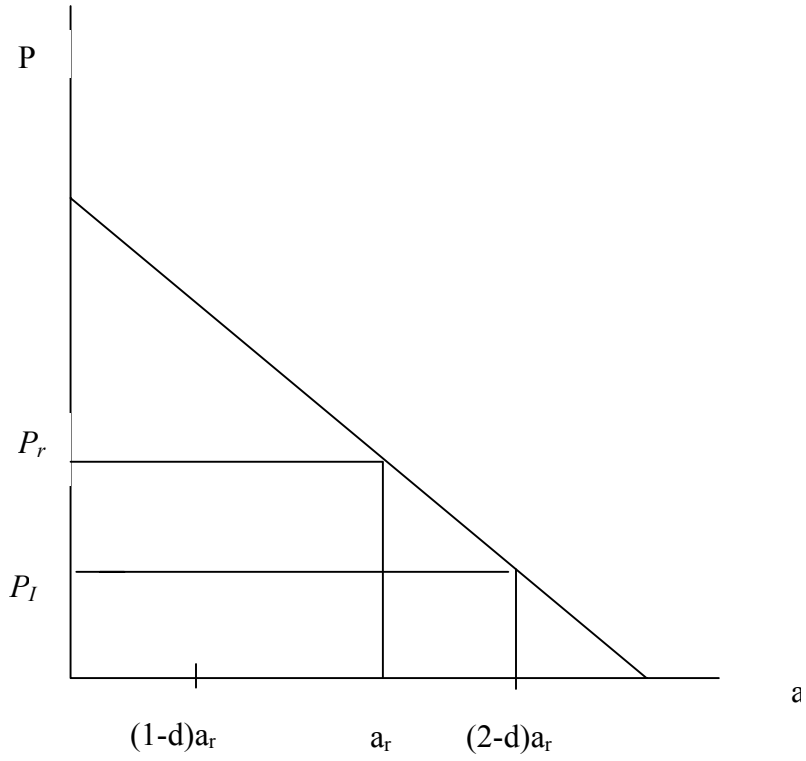


Figure 11 examines the situation for a listener that listens to both the OTA radio station and its Internet competitor, for a positive value of d less than 1, for $h=H$ and a_I, the amount of ad time purchased from the Internet radio service, equal to a_r.

Figure 11 An advertiser's demand curve for access to radio audience who listen to both Internet and OTA programming



As can be seen, if the Internet radio service is to sell as much ad time as the OTA radio station, it will have to do so at a price per listener of P_I, which is below the price at which OTA-only listeners are sold. The Internet service can increase P_I by reducing a_I, but there is no value of $a_I > 0$ for which we do not have $P_r > P_I$. This relationship holds for any $h > 0$. The only way around this dilemma is to develop a significant audience that does not listen to OTA radio. But as long as Internet radio services cannot reach drivers in their cars, where a large fraction of radio listening occurs, this scenario is unlikely. However, if more narrowly targeted programming can induce a strong preference for the

Internet service in situations where both are available, Internet radio ad prices still could be raised somewhat.

V. Audience segmentation to reduce costs

More narrowly targeted programming could also improve the cost side of the Internet radio profit equation. Programming with broad appeal is likely to attract an audience with a diverse set of preferences in products. As a result, the percent of listeners to an in-program ad that are likely purchasers of an advertiser's product will often be small. To the extent that purchase patterns are correlated with specific preferences in programming, programming targeted to a narrow spectrum of tastes might also produce an audience that is more homogeneous in terms of its product preferences. This could increase the percent of audience seen as valuable to prospective advertisers.

For OTA stations whose costs do not vary with the number of listeners in their audiences, this is not a material consideration. For Internet radio services, however, each listener adds to their streaming costs whether they are valuable to advertisers or not. Thus cost considerations, in addition to positioning pressures due to the likely presence of a plethora of on-line competitors, points to a much bigger payoff to narrowly targeted content for Internet radio services than for OTA radio stations.

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