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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
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Amendment of Part 73 of the Commission's Rules To Permit the Introduction of Digital Audio Broadcasting in the AM and FM Broadcast Services	)	RM-9395
In the Matter of	)	
	)	
Amendment of the Commission's Rules with Regard to the Establishment and Regulation of New Digital Audio Radio Services	)	GEN Docket No. 90-357

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REPLY COMMENTS OF LUCENT TECHNOLOGIES INC.

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EXECUTIVE SUMMARY

In its comments on the USADR Petition, Lucent stressed four points that are necessary to focus upon at this stage of digital development.

- First, it is essential that activities be focused upon the ultimate goal of FCC adoption of a single broadcast digital transmission standard.

- Second, IBOC is by far the preferred method for both AM and FM broadcasters to initiate and transition to digital audio broadcasting.

- Third, it is too early in the developmental process to be drafting and analyzing specific rules changes. Most of the information required for meaningful discussion of specific rule changes can be ascertained only through further developmental efforts and testing of real hardware in the field.

- Finally, the FCC (and other appropriate governmental agencies) should participate actively in this process by collecting and analyzing relevant information as it becomes available from proponents' developmental work and field testing. An efficient manner of accomplishing this objective would be to hold the record open in the proceeding already established for this purpose, GEN Docket 90-357; and to use this record as a basis for proposing specific rule changes in a Notice of Proposed Rulemaking to be issued after evaluation of the field tests that proponents have agreed to conduct.

Many commenters agreed with most of these points. Indeed, every commenter addressing the FCC's role emphasized the need for the government to mandate appropriate standards in order to promote the widespread availability of free, over-the-air digital broadcasting to all Americans. The government has an indispensable role in assuring that the standards selected are optimal from a broad social perspective because of the unique role that broadcasting plays in providing not only entertainment, news, and public affairs programming, but also in providing the means of quickly informing the public of perilous weather conditions and other events that affect the public health and welfare. Radio especially is effective in this regard because it is present in almost all automobiles as well as homes, and easily reaches citizens who otherwise would be difficult to inform of impending perils.

The objectives for an IBOC digital radio system should include such broad public interest objectives. Lucent's digital IBOC system has been designed to meet these beneficial objectives. Its system will protect analog stations and existing consumer receivers for as long as necessary. The system design permits broadcasters to move to hybrid digital or all-digital at their own individual pace. A system that meets these objectives will permit the transition from analog to digital to be determined by marketplace forces on an individual station-by-station basis.

It also is to be emphasized that during the transition ("hybrid") period, broadcasters using Lucent's system will deliver to their entire service area all aspects of their digital service, including any digital emergency alert information or other data services. Lucent's system is being designed to not rely on the analog signal in the hybrid mode to fill in difficult reception areas, but rather, to deliver its digital signal throughout each broadcaster's existing service area.

To ensure that any new digital system adequately provides for public interest objectives such as these, the industry standard-setting procedure must evaluate each proponent system for these objectives, and must be fair and unbiased in doing so. This is particularly important when those possessing proprietary technology are advocates for a specific standard that would favor their technology over another. The public will benefit from there being established a fair and impartial selection process, and will be harmed to the extent there is not. Having a fair process likely will save years of legal and technical debate in regulatory and judicial fora, and will significantly speed the day when the public has access to a full array of digital broadcast services.

In addition, digital transmission standards inevitably implicate issues of efficient spectrum use. Because spectrum is an important <u>unpriced</u> input to radio broadcasting, there is a pronounced danger that *de facto* or voluntary standards will not correspond with social

optimums. This strongly recommends that a neutral body such as the FCC be the final arbiter between competing proprietary standards. A standard arrived at by a "majority" of industry participants, even if the overwhelming majority, may not achieve the best societal result.

For its part, Lucent is in the process of establishing field tests in multiple markets that represent the full array of propagation environments. These markets represent terrain of all types: urban, suburban, and rural; flat, hilly, and mountainous; and water as well as desert. The markets where field tests will be conducted also represent various radio environmental conditions for both AM and FM, from crowded with short-spaced stations to relatively lightly loaded. Our objective is to test Lucent's IBOC system under all of the most difficult environments, and to use the data obtained from such testing to improve Lucent's system design and to form specific recommendations for FCC rule changes needed to govern IBOC digital.

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REPLY COMMENTS OF LUCENT TECHNOLOGIES INC.

I. INTRODUCTION

Lucent Digital Radio (Lucent) is at the forefront of digital audio technology and has developed digital transmission technology for the AM and FM radio bands. Lucent's technology has been designed for use as an In-Band On-Channel (IBOC) system to facilitate the transition of broadcasters to digital technology. Lucent's design permits individual station transition periods determined by broadcasters on a station-by-station basis, rather than by Government on a necessarily "one-size-fits-all" basis. Accordingly, Lucent's system will deliver a digital signal to the entire service area of all current broadcasters without interfering with broadcasters' analog signals.

II. COMMENTERS OVERWHELMINGLY SUPPORT COMMISSION ADOPTION OF A SINGLE BROADCAST TRANSMISSION STANDARD AND IBOC AS THE PREFERRED DIGITAL METHOD

It is important that any new digital system further the public interest objectives of this Nation's free, over-the-air broadcast service. Therefore, as every commenter agreed, the FCC's role is essential to ensuring that the standard-setting procedure is fair and unbiased. The process must be geared to mandating appropriate standards for uniform use by broadcasters. Throughout the process, the FCC (and potentially other agencies) has an indispensable role in assuring that the standards selected are optimal. Only with its active participation can there be assurance that the standards selected are optimal both from the broad social perspective in the form of improved quality, quantity, and variety; and from the more precise perspective of providing the means for communicating emergency alert and other high priority news and information.

In its comments to the USADR petition, Lucent stressed four main points that it believes are necessary for the successful introduction of terrestrial IBOC digital audio broadcasting ("IBOC DAB"). First, Lucent supported IBOC as the most efficient and easily implemented method of digital broadcasting;[1] second, Lucent highlighted the necessity for comprehensive field testing prior to the adoption of interference rules for IBOC DAB;[2] third, Lucent detailed the necessity for a single *de jure* standard for IBOC DAB;[3] finally, Lucent proposed that the Commission use an existing *Notice of Inquiry* to accept detailed technical information as it becomes available from all sources, from field tests or other activities, before proceeding with a *Notice of Proposed Rulemaking*.[4] Lucent notes that the comments received from other parties in this proceeding demonstrate broad-based agreement with Lucent's position.

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1 Lucent Comments at 7-15.

2 Lucent Comments at 15-18.

3 Lucent Comments at 22.

4 Lucent Comments at 25-28.

While the record contains a variety of views on some distinct issues, there appears to be unanimous agreement on the need for a single standard. In fact, every Commenter addressing this issue supported the adoption of a single mandatory standard.[5] Significantly, this support was uniform across affected industries, including broadcasters, manufacturers of broadcast transmission and reception equipment, and the three digital proponents. There appeared to be widespread recognition of the unique role that broadcasting plays in providing not only entertainment, news, and public affairs programming, but also in providing the means of quickly informing the public of perilous weather conditions and other events that affect the public health and welfare. The following Comments submitted by CEMA are representative of the manufacturers' support for a uniform IBOC DAB standard:

> Technical standardization is critical . . . A required standard will protect consumers against losses by assuring them that their investments in DAB equipment will not be made obsolete by a different technology. In addition, requiring the use of a single standard guarantees compatibility. This assures consumers that DAB equipment used to listen to one station can be used to listen to every other station.[6]

Broadcasters also concur in the need for technical standardization. The NAB has been pursuing the development and implementation of IBOC DAB for nearly a decade and has had the establishment of technical standards as a stated objective since 1993:

> For DAB to be successfully introduced in the marketplace, it is necessary to have a single technical standard. Technical standards are necessary to generate

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5 *See, e.g.,* Comments of ABC, Inc. at 4; Comments of CBS at 9-10; Comments of Clear Channel Communications, Inc. at 5; Comments of CEMA at 11-12; Comments of Cumulus Media, Inc. at 7; Comments of Digital Radio Express, Inc. at 3; Comments of Ford Motor Company at 2; Comments of Gannett Co., Inc. at 4-5; Comments of Greater Media, Inc. at 9; Comments of Heftel Broadcasting at 3; Comments of NAB at 3; Comments of Radio One, Inc. at 4; Comments of Radio Operators Caucus at 5; Comments of Susquehana radio Corp. at 4.

6 Comments of CEMA at 11-12.

> investment in manufacturing and confidence that the products designed will, in fact, perform as designed once they are manufactured.[7]

Lucent is steadfastly committed to adoption of IBOC DAB as the most appropriate and easy to implement terrestrial digital radio broadcast system. IBOC DAB is superior to any other proposed digital radio system because of its spectral efficiency, ease of transition for both broadcasters and consumers, and low implementation costs. In fact, these are the same attributes highlighted by several Commenters that also support IBOC DAB as the most appropriate digital radio system.[8] For example, CBS expressed its support for IBOC with the following:

> IBOC technology is the only proposed DAB technology that integrates digital broadcasting into the existing analog AM and FM radio transmission system, eliminating the need for additional spectrum, and allowing listeners to continue to locate their favorite radio broadcast stations at the same place on the radio dial.[9]

Importantly, even though there is not yet a consensus on which IBOC DAB system is the most appropriate, these Comments reveal widespread support for the general proposition that IBOC is the best DAB solution.

III. COMMENTERS AGREE THAT FIELD TESTING OF HARDWARE IS ESSENTIAL TO ANALYZING AND ADOPTING APPROPRIATE CHANGES TO THE FCC'S RULES

Although Lucent fully supports IBOC DAB, it opposed the premature issuance of specific service rules prior to the completion of field testing of any of the competing systems. Because IBOC entails the deployment of a highly complex, technically demanding, new broadcast architecture, it must be submitted to comprehensive field tests before it can be introduced successfully. The lack of field test data was a deficiency in the USADR petition that

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[7] Comments of NAB at 3 (quoting, *Resolution of the NAB Radio Board of Directors*, June 23, 1993, Pentagon City, VA.).

[8] *See, e.g..,* Comments of CBS at 6; Comments of Cumulus Media at 5-6; Comments of NAB at 2-10; Comments of Radio Operators Caucus at 3; Comments of Susquehanna Radio at 2.

[9] Comments of CBS at 6.

Lucent noted in its Comments, and was highlighted by several other Commenters as well.[10] The following quote summarizes the view that runs throughout many of the Comments:

> The Commission should move cautiously in proposing any rules regarding digital radio. . . . The fundamental requirement of a successful transition demands that any proposed rules relating to digital radio be based firmly ***in extensive field testing of all potential circumstances***, as well as supported by computer simulations and theoretical analyses.[11] [emphasis added]

The repeated call for field testing to establish the technical compatibility of IBOC DAB with existing radio broadcasts also lends support to Lucent's final point. Lucent urged the Commission to proceed within the context of an existing *Notice of Inquiry* proceeding to establish a comprehensive record upon which to commence a rulemaking proceeding for the introduction of IBOC DAB. Again, the record supports Lucent's view. In addition to the many Comments supporting field testing prior to adopting service rules for IBOC DAB, other Commenters also "support the initiation of a rulemaking proceeding *to further the development of a DAB technical standard.*"[12] [emphasis added]

Big City Radio specifically echoed Lucent's point urging the use of an *NOI* proceeding as the necessary next step in the process for the development of IBOC DAB:

> The current proposal which has not undergone adequate field testing or computer simulation, risks significant -- and even fatal -- interference to many existing AM and FM licensees. Because the Petition does not demonstrate adequately that its proposal would not increase interference to existing radio licensees, the Commission should deny the Petition as premature and ***instead issue a Notice of Inquiry on the subject of digital radio.***[13] [emphasis added]

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10 *See, e.g.,* Comments of Big City Radio, Inc. at 3; Comments of CEMA at 14; Comments of Cumulus Media, Inc. at 8; Comments of Digital Radio Express, Inc. at 4; Comments of Greater Media, Inc. at 7-9; Comments of NAB at 14.

11 Comments of Big City Radio, Inc. at 3.

12 Comments of National Public Radio at 7.

13 Comments of Big City Radio, Inc. at 2.

The USADR petition for rulemaking is flawed by its lack of field test data, and consequently premature. For this reason alone, the Commission would be justified in considering it, the information submitted in response to it, and information being developed -- including the results of field tests -- in GEN Docket No. 90-357.

IV. THE COMMISSION MUST ASSURE FAIR PROCEDURES IN THE STANDARDS RECOMMENDATION PROCESS AND ULTIMATELY CHOOSE BETWEEN CONTENDING TECHNOLOGIES

The government has an indispensable role in the articulation of DAB standards, just as the comments indicate. In order to assure the coordination necessary among the various parties involved in the supply and consumption of broadcast radio, the FCC should mandate appropriate standards and effect the changes in Commission rules necessary to reflect the new standards. The Commission also has an indispensable role in assuring that the standards selected are optimal from the broadest possible social perspective. To accomplish that, it must assure that the process of assembling the information necessary to make the selection is scrupulously fair. It must assure that the criteria by which competing standards are to be judged are carefully specified, reflective of technical merit, susceptible of implementation, and promotive of consumer welfare. And the Commission must assure that the evaluation is fair and restricted only to matters relevant.

That industry standard-setting procedures must be fair and unbiased, particularly where those possessing proprietary technology are advocates for a specific standard that would favor their technology and exclude another, has a long jurisprudential history. The concern with the potential anticompetitive problems resulting from private standard setting bodies unsupervised by governmental processes has been demonstrated in a number of cases arising under the antitrust laws. The Supreme Court has held that since industry standard-setting bodies have the

ability to inflict significant harm on consumers through competitive harm on proponents of an excluded technology, anticompetitive standard-setting conduct is not immune from the antitrust laws. This is so even when the established standards are subsequently widely adopted by governmental regulatory agencies in the form of required standards or mandated industry codes. Allied Tube & Conduit Corp. v. Indian Head, Inc., 486 U.S. 492 (1988). In that case, the proponents of a standard "packed" the association meeting that voted on the standard with persons favorable to their position. The Court held that antitrust liability could result from such conduct. Other actions that have contributed to findings of antitrust liability include stacking the representation in key committees. Thus, not only must the procedure be unbiased at the final decision making level, but also at the fact gathering and recommendation level leading to the final decision. American Soc'y of Mechanical Engineers v. Hydrolevel Corp., 456 U.S. 556 (1982). In the context of IBOC DAB standards this suggests, at the very least, that all steps in the procedure leading to the adoption of the standard should be fair and impartial in order to meet applicable legal requirements and result in the optimum social outcome.

Just as important as procedural "due process," however is the requirement that a neutral body such as the Commission be the final arbiter among competing proprietary technologies. According to Professors James Anton and Dennis Yao (a former FTC Commissioner), particularly where proprietary technologies are involved, the standard-setting body, even when it requires due process, must be particularly acute in scrutinizing proposed standards to prevent any suboptimal outcomes that may result from the careless adoption of a specific standard. Standard Setting Consortia, Antitrust and High Technology Industries, 64 Antitrust L.J. 247 (1995). They base this conclusion on recent research indicating that even supposedly impartial procedures may result in anticompetitive effects:

> [t]hese lines of research indicate that (a) subgroups can take advantage of apparently impartial procedures to obtain their preferred results, (b) the group optimal outcomes may not emerge, even without strategic attempts to manipulate outcomes, and (c) the status quo is an important determinant of outcomes.

Id. at 257.

The fact that in the DAB context the distribution among firms of the most important input for implementation of the technology -- radio spectrum -- is not priced means, according to Professor Farrell, that an optimal outcome is less certain than in the usual case.

> In the present case, however, there is a very clear potential for inefficient incentives. Because spectrum is not explicitly priced to the broadcasters, they have a clear inefficient incentive not to economize on it. That is, because of this important unpriced input, each broadcaster's preference between (for instance) USADR's standard and Lucent's would be predictably and systematically biased against the more spectrally efficient (if indeed they differ in spectral efficiency), relative to the best estimates of the true overall benefits available from the two.[14]

The Commission must therefore be particularly acute in assessing possible alternative technologies.

Moreover, a standard arrived at by "consensus" among industry participants, a solution that is tempting because it delegates the burden of final decision making to someone else, may not achieve the best societal result. Professor Farrell points out reasons to be wary of so-called "bandwagons." "As a matter of economic theory, bandwagons do not necessarily form at the optimal time for the selection of a standard.... Nor do bandwagons necessarily form on the best available technology."[15] As Anton and Yao point out with respect to disagreements among industry participants,

> While one can attribute some of the problem to purely technical disagreements, there is strong reason to believe that that is not always the case. Thus, we surmise that the incentives associated with coming to agreement on a standard will not always overwhelm the incentives to gain a competitive

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14 Statement of Joseph Farrell on Standard-Setting in Digital Radio, App. at 6.

15 *Id.* At 4.

> advantage, say, through attempts to raise rivals' costs or to develop an installed base.

Id. at 259. To guard against such an outcome, a "consensus" approach should be avoided or approved only after careful Commission analysis.

In the final analysis, these inherent difficulties in establishing a DAB standard mean that not only must the Commission insure fairness in the procedures, it must also examine the actual or potential self-interest of the proponents and, while recognizing the legitimate role that self-interest plays in economic decision making, carefully weigh that self-interest in an effort to achieve a standard that is technologically superior and at the same time in the best interests both of consumers and the most efficient allocation of spectrum. In short, a "consensus" that is arrived at by only one of several interested constituencies should give way to a technologically and socially superior system. It is inevitably the Commission's responsibility to protect the interests of the under-represented segments of society and make the ultimate choices that will yield the optimum outcome for all. Even the fairest of procedures cannot by themselves guarantee that result without the final choice being made by the Commission.

V. LUCENT'S DESIGN HAS SPECIFIC PUBLIC INTEREST BENEFITS

For both its AM and FM IBOC systems, Lucent's design is intended to achieve important public interest objectives. Its systems will provide the maximum transmission capacity within the licensed broadcast channel bandwidths; and will cover with the digital signal, even during the transitional (hybrid) period, the same geographic area as covered with today's analog signals. These objectives are fundamental to Lucent's design for both the hybrid (transitional) and all-digital modes.

Lucent's design accomplishes these objectives with a completely digital signal through a multi-streaming process using its patented Perceptual Audio Coding (PAC). In this manner, listeners will be able to derive the benefits of the digital signal – including data emergency alerts and other possible data program information or services -- everywhere within the broadcast service area.

Lucent also had designed its systems to be compatible with existing analog broadcast signals. There should be little to no impairment to the existing broadcasts. Implementing the Lucent design, therefore, would eliminate any need for establishing a specific transition period. Each broadcaster – urban, suburban, or rural – could individually elect when and if to (a) begin hybrid digital broadcasts, and (b) terminate analog broadcasting in favor of an all-digital signal. Even within the same market, each broadcaster would be empowered to make its own unique decision based on marketplace and other factors relevant to its choice. In this fashion Lucent's system is based upon broadcasters and the marketplace electing when digital service is offered, when analog service is terminated.

Lucent's system also is designed to be flexible. At a minimum, both AM and FM stations should realize substantial improvement in the audio quality of their stations in both the transition (hybrid) mode and in the all-digital mode, as compared with today's AM and FM audio quality. In addition, the efficient digital technology constitutes a flexible digital platform which could be used to provide audio quality approaching that of multi-channel home theater systems; or to provide an array of related program or other digital data, including emergency weather alerts, local traffic reports, and other important information.

VI. FIELD TESTING

Lucent intends to initiate field tests of its digital system within the next several months, and to have significant testing completed and evaluated by the end of 1999. Lucent's field tests will be conducted in multiple markets that represent the full array of propagation environments. These markets represent terrain of all types: urban, suburban, and rural; flat, hilly, and mountainous; and water as well as desert. The markets also represent various radio environmental conditions for both AM and FM: from crowded with short-spaced stations to relatively lightly loaded. Lucent's objective is to test its IBOC AM and FM systems under all of the most difficult environments. Assuming that its field tests are successful, Lucent would then be in position to recommend specific rule changes to the Commission in order to introduce digital broadcasting within the current AM and FM bands.

With regard to testing, it would be in the public interest – and would speed the introduction of digital IBOC to American consumers – if a common set of meaningful test parameters were agreed to by the proponents. At the very least, Lucent believes that all proponent systems must measure their digital coverage areas, especially in the hybrid mode, compared to the host analog signal. In addition, digital audio quality must be measured against analog audio quality as well as against a digital benchmark, such as CD-quality, in order to permit comparison of the various proponent digital systems. Finally, each system should be tested sufficiently so that its data capabilities are quantified and the trade-off between increased audio quality and additional data services can be compared among the proponent digital systems.

The Commission must ensure that these and any additional public interest objectives are tested by all proponents in a meaningful manner. Otherwise, at the end of 1999 additional field testing will be required and initiation of digital broadcasting will be more distant than need be

the case. There is no reason for all parties incurring substantial additional costs as the price of not establishing clearly all the relevant and meaningful objectives for which each proponent system should be tested and evaluated.

VII. CONCLUSION

Lucent believes that the IBOC digital future holds much promise for both AM and FM broadcasters. However, for broadcasters to be allowed to participate in the digital future as rapidly as possible, the Commission must exercise a leadership role to ensure that the field tests to be conducted in the coming months provide the information and data that it requires to select a digital system, adopt any rule changes necessary, and permit IBOC digital broadcasting to be initiated by existing licensees. Failure to exercise a minimum of foresight over the next few months will impede broadcasters from realizing the digital future, and delay the time when the American public will have access to the improved audio quality and new data services that digital broadcasting will enable.

Respectfully submitted,

LUCENT DIGITAL RADIO

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January 25, 1999

APPENDIX

Statement of Joseph Farrell on Standard-Setting in Digital Radio

January 1999

Joseph Farrell

Joseph Farrell is Professor of Economics and Affiliate Professor of Business at the University of California, Berkeley, where he has taught since 1986. He is also an Affiliate of the Center for Regulatory Policy, the Consortium for Research in Telecommunications, and the Center for Law and Technology.

He is an Editor of the *Journal of Industrial Economics*.

During 1996-1997, Professor Farrell served as Chief Economist of the Federal Communications Commission, helping implement the dramatic changes in telecommunications policy and regulation called for by the Telecommunications Act of 1996.

Professor Farrell is a former President of the Industrial Organization Society. His research in industrial organization has focused largely, though not exclusively, on issues of standard-setting, competition with network effects, and buyer lock-in.

A full resume can be found at
http://elsa.berkeley.edu/~farrell/cv.pdf

Statement of Joseph Farrell on Standard-Setting in Digital Radio

January 1999

Summary. I have been asked by counsel for Lucent Digital Radio to comment briefly on some issues of standard-setting in digital radio in the United States. Based on a review of limited materials available to me, I believe that the Commission should encourage unbiased field testing of the proposed technologies so as to ensure that the final decisions on standards are made in a reasonably informed manner. This effort will be well worth while. Moreover, because broadcasters and manufacturers do not internalize the social costs of different spectrum efficiency of different standards, the Commission could quite reasonably decide to overrule any industry consensus that might develop on a relatively spectrum-inefficient technology, and instead mandate a more spectrum-efficient standard. In order to make that call, more information is needed.

Background. Digital technology offers an opportunity to replace the existing analog system with a more efficient digital system. Manufacturers and the suppliers of technology, including Lucent, are interested in supplying equipment for them to do so and for consumers to receive digital broadcasts. The problems before the Commission include (a) whether to mandate a standard, (b) if so, what standard to mandate, and (c) how and when to decide on (a) and (b).

USADR, Lucent, and Digital Radio Express have competing proposals for digital radio standards. While these proposals have been the subject of substantial development effort, I understand that they have not been thoroughly field-tested. Moreover, the standards differ significantly in their technical characteristics. I understand that USADR's proposal uses Advanced Audio Coding, while Lucent's uses Perceptual Audio Coding. Lucent's also uses multi-streaming techniques, which lead to more graceful degradation as the signal weakens and may have spectrum-efficiency advantages. In general, Lucent claims that its system has substantial technical advantages. But, absent field testing, it is hard to know how the technical performance of the alternative systems will compare in practice.

The proposals also differ in less "purely technical" respects. Lucent believes that its system will be more efficient in its use of spectrum, and that its proposal is less likely as a practical matter to oblige smaller or otherwise reluctant broadcasters to convert unwillingly to digital technology after a transition period. But these beliefs also seem to depend on claims about technical performance and about how much interference would be caused to analog broadcasts by nearby full-power digital broadcasts using different standards.

Analysis. In an environment of considerable technological uncertainty such as this one, and facing a decision that will affect terrestrial radio for many years, there are large benefits to acquiring more information. Specifically, I understand that field tests could be carried out within a matter of months, providing substantially more information on the systems' technical performance under real-world conditions. Thus, simply from the perspective of optimal decision theory, it would appear that careful field testing is well worth while.

In October 1998, Dr Stanley Besen and Dr John Gale filed, on behalf of USADR, an analysis arguing in favor of a Commission-mandated standard. They stressed the especially great social value of a ubiquitous standard in radio, and argued that, for a variety of reasons, such a standard might not readily come about absent a government mandate. Specifically, they pointed to the possibility of incompatible choices and the possibility of excessive "wait-and-see" behavior by manufacturers, broadcasters, and consumers. In general I would agree that those factors could well be important in so decentralized an industry, and that they would constitute arguments in favor of a mandate.

However, recent developments suggest that the problem may be more complex than Drs Besen and Gale suggested. While they stressed the possibility that no clear front runner would emerge, I understand that, in the interim, a number of broadcasters have invested in USADR and generally have expressed support for its standard. If that partial "bandwagon" grows or looks likely to grow, it may appear to obviate the concerns that Besen and Gale discussed, by providing a kind of limited "industry consensus." In their place it poses the problem: Should the Commission (actively or passively) endorse such a bandwagon choice, or should it take some independent action to help ensure an efficient outcome?

As a matter of economic theory, bandwagons do not necessarily form at the optimal time for the selection of a standard. If some broadcasters and/or manufacturers see advantages in moving early or disadvantages in being late, "pre-emption" motives can easily overcome the value of awaiting better information, and thus cause a bandwagon to be premature. Nor do bandwagons necessarily form on the best available technology. For example, if a large player is expected to choose one technology for its own reasons (for instance perhaps an ownership interest), others may see little alternative but to follow, even if they prefer another technology, if their need for compatibility is strong enough.

As economists have increasingly recognized, therefore, bandwagons – whether of adoption or of adherence to a proposed industry "consensus" – are not an ideal mechanism, and the fact (without more) that a substantial number of broadcasters favor a particular standard does not necessarily guarantee that that standard is optimal. A degree of skepticism is perhaps especially warranted where interests differ (e.g. perhaps due to broadcasters' very different sizes), where ownership interests intervene, and where a proposal may in practical terms (because of interference between full-power digital broadcast and analog) eventually become compulsory on unwilling players.1 Thus, as a general matter of economic theory, even if a majority of broadcasters were to gather around a particular standard, this would not guarantee that that standard is optimal.

In general this argument – in brief, that bandwagons are imperfect – by itself is certainly not enough to justify a government mandate of a particular standard. If nothing else, mandates are themselves imperfect selectors of technology, and have other important costs such as future inflexibility. Furthermore, despite the caveats, there is at least *some* presumption that a market consensus is reasonably good, absent any glaring inefficient incentives.

1 Dr Besen and Dr Gale suggest in some places that such compulsion may be a good thing, through avoiding the possible excess inertia in adoption – even though their footnote 35 suggests that excess inertia is unlikely to be a very grave problem. In other places, Besen and Gale more conventionally note as a benefit of the USADR proposal

In the present case, however, there is a very clear potential for inefficient incentives. Because spectrum is not explicitly priced to the broadcasters, they have a clear inefficient incentive not to economize on it. That is, because of this important unpriced input, each broadcaster's preference between (for instance) USADR's standard and Lucent's would be predictably and systematically biased against the more spectrally efficient (if indeed they differ in spectral efficiency), relative to the best estimates of the true overall benefits available from the two.

This bias – due to the broadcasters' failure to internalize the opportunity cost of spectrum – could surely be very substantial if spectrum efficiency differs substantially. As a result, it would be unwise for the Commission to endorse an industry consensus that sacrifices spectral efficiency without investigating whether the object of such a consensus is so much superior in other respects as to make that sacrifice efficient. Absent a mechanism to price incremental spectrum efficiently, it would appear that at a bare minimum the Commission should take into account hard technical information on the systems' real-world performance, and weigh this against a considered view of the value of incremental spectrum.

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that broadcasters will not be legally required to convert to digital – even though they seem to believe (e.g. their footnote 36) that analog service will be substantially degraded after the transition period.

Conclusion. None of these arguments shows that the Commission should *necessarily* reject the USADR standard. It could be, for all I know, that its technical merits are so much greater than the alternatives' that those differences outweigh any issues of spectrum efficiency. But absent field tests to compare technical merits and some attempt to gauge any spectrum-efficiency differences and weigh their importance, there is no way for the Commission to learn that. Certainly any apparent bandwagon of support for USADR does not prove it. Finally, it is worth stressing that absent any effective pricing of spectrum (or internalization of its opportunity cost), only the Commission is in a position to weigh the value of spectrum efficiency.

CERTIFICATE OF SERVICE

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