Before The
Federal Communications Commission
Washington, Dc 20554

In the Matter of	)	
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	)	
Second Periodic Review of the	)	MB Docket No. 03-15
Commission's Rules and Policies	)	
Affecting the Conversion	)	RM 9832
To Digital Television	)	
	)	
Public Interest Obligations of TV	)	MM Docket No. 99-360
Broadcast Licensees	)	
	)	
Children's Television Obligations of	)	MM Docket No. 00-167
Digital Television Broadcasters	)	
	)	
Standardized and Enhanced Disclosure	)	MM Docket No. 00-168
Requirements for Television Broadcast	)	
Licensee Public Interest Obligations	)	

To: The Commission

Comments of the Merrill Weiss Group, LLC

Summary

These comments on the FCC NPRM announced as part of the Second Periodic Review process deal with a promising technical solution to some of the difficulties that numerous broadcasters have faced in delivering sufficient signal levels to viewers in their homes. The technology involved is that of Distributed Transmission, which combines the ability to provide more uniform signal levels over a wider service area with the spectrum efficiency that can come from causing less interference. The comments herein focus on the issues raised by the FCC in the NPRM with respect to distributed transmission, addressing each of the related questions asked by the Commission. In addition, comments will be made on some related areas that can be impacted by the use of distributed transmission techniques.

In the NPRM, the Commission seeks input regarding five major topics related to the authorization of distributed transmission technologies. These comments address each of those topics and provide suggestions on how to treat each of them. In some cases, alternative approaches are provided so that the Commission can judge which may be the best policy for handling certain aspects of the use of distributed transmission techniques.

In summary, these comments support the need for the Commission to enable the use of distributed transmission techniques as a tool that can be applied by broadcasters to overcome a variety of transmission difficulties and to enhance their services to the viewing public. They explain why it is necessary for the facilities built in distributed transmission networks to be treated as primary rather than secondary parts of the broadcast services. They suggest two methods for determining the location and service area of distributed transmitters – one based on service contours and one based on Designated Market Areas (DMAs). These comments suggest that the power and antenna height limits in the FCC's Rules for DTV stations should also be applied to distributed transmitters. Similarly, the emission mask specified in the Rules for DTV stations should also be applied to distributed transmitters. Moreover, the Commission's existing interference protection methods and limits should be used for analysis of distributed transmission systems, with minor extensions added to account for the use of multiple transmitters. The extensions needed to methods and software are described in some detail. These comments suggest that the Commission should take a light-handed approach to the imposition of additional technical standards specific to the operation of distributed transmitters and networks. Broadcasters should have the flexibility to adjust their networks as experience shows they can be improved. Nevertheless, techniques are described that permit the measurement and monitoring of the operation of distributed transmission networks and that, in fact, may be useful in the identification of interference sources involving transmitters not included in distributed transmission systems.

These comments begin with an introduction to the subject of Distributed Transmission and its history in the Commission's Advanced Television proceedings. They then turn to the specific issues that the Commission has raised in the NPRM. They next consider the benefits and limitations of distributed transmission techniques. Finally, they discuss a number of matters connected with distributed transmission technology to provide the technical underpinnings for the decisions the Commission must make.

Introduction

The Federal Communications Commission recently released its Notice of Proposed Rulemaking, MB Docket 03-15, "Second Periodic Review of the Commission's Rules and Policies Affecting the Conversion to Digital Television," Adopted January 15, 2003. In the NPRM, the FCC indicated that it is now ready to address the matter of Rules for and authorization of use of Distributed Transmission systems by broadcasters.[1] The Commission briefly explained the technology and raised a number of questions in each of five major areas for consideration. These topics are the primary vs. secondary status to be accorded to distributed transmitters; the location and service area of distributed transmitters; the power, antenna height and emission mask to be used by distributed transmitters; the interference protection required when distributed transmitters are in use; and the technical standards to be applied to distributed transmitters. The Commission also asks whether distributed transmission technology generally should be permitted and the relevant rules and policies that would be needed in order to enable routine use of the techniques.

The Merrill Weiss Group LLC ("MWG") herein provides information for the Commission's consideration with respect to the technology of distributed transmission and responds to each of the questions raised in the NPRM regarding the matter. In doing so, MWG proposes approaches to the various Rules that will be required to enable licensing of distributed transmitters. In some cases, alternatives are provided so that the Commission can weigh the divers factors and determine the best course to take. There are implications from the potential utilization of distributed transmission with respect to some of the questions that the Commission has raised in other areas, and where those implications exist, the related questions also will be addressed.

[1] NPRM at ¶99.

Distributed Transmission is a technology that can address many obstacles and issues faced by broadcasters in delivering digital television signals to viewers in their homes. Distributed transmission systems, when fully applied, can allow higher signal levels and signal delivery from multiple directions in urban areas, enabling set top reception and overcoming the obstacles of urban canyons. They can help reduce the cost of power – a significant issue especially for UHF operation. They can allow the use of shorter towers, such as the many medium size cellular telephone towers the tops of which often go unused, thereby avoiding many zoning problems. Because they can utilize lower power transmitters on smaller towers, they can cause smaller interference zones around their service areas, thereby permitting greater frequency reuse and corresponding spectrum efficiency. Distributed transmission systems can also overcome terrain obstacles in big markets such as Los Angeles, Pittsburgh, San Francisco, and Seattle, while they can help extend service over widespread areas in rural markets such as much of the Dakotas, Utah, and Wyoming. They can help to make a staged rollout of maximized service possible, too, for small market or public broadcasters that are having trouble financing their construction.

The Merrill Weiss Group LLC comprises consultants in electronic media technology, technology management, and management. Having a twelve year history in consulting and over sixty years combined experience in the broadcasting industry and related fields, its consultants handle projects ranging from broadcasting to cable to satellite, from broadband wireless to advanced video compression technologies to digital rights management, with video and data networking plus data broadcasting in between. Its principal has been involved in the standard-setting process for digital television technology from the inception of that work in the mid-1970's, including participation in the entirety of the FCC Advisory Committee process that led to the current ATSC standards and FCC Rules.

The Merrill Weiss Group LLC is engaged in the design and implementation of facilities for Digital Television stations that will be directly affected by the Rules changes proposed in the NPRM. It has been working on projects for stations in widely separated parts of the country that nonetheless can benefit from application of similar techniques.

In one example, MWG was instrumental in developing a distributed transmission network for a station that could not reach the population centers within its service area by any other means. The Commission granted an experimental license to the station to enable its development of the facilities necessary to serve its audience until such time as Rules covering the routine operation of distributed transmission systems are in place. MWG has developed the technology to enable the synchronization of transmitters in distributed transmission applications, and that technology has been adopted by the Advanced Television Systems Committee (ATSC) in the form of a standard that is currently at the Candidate Standard stage in the ATSC approval process.[2]

These comments have been prepared to offer to the FCC a greater understanding of the difficulties that some stations face and some solutions that can be applied if only the Commission will allow them. In some ways, the subject is "unfinished business" – a matter that the Commission recognized in earlier proceedings but failed to address. It is hoped that, in the context of the instant review, the Commission will adopt Rules that authorize the routine licensing of distributed transmitters, thereby enabling flexible solutions to technical problems confronted by many broadcasters in providing universal DTV service to the public.

Background Information on Distributed Transmission

Signal boosters of one sort or another have been in use in a variety of services for many years. They have even been available to NTSC television broadcasters under the FCC Rules. But they have been permitted under assumptions about the transmission system that no longer need limit the way that systems are designed. The very term "booster" and the secondary status boosters are accorded carry an implication that there is to be a main station intended to reach the bulk of a station's viewers and a supplementary transmitter intended to deal with out-of-the-way, perhaps expendable, portions of the station's

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[2] ATSC CS/110, Transmitter Synchronization Standard for Distributed Transmission, available at www.atsc.org/standards/cs_documents/cs_110a.pdf.

See also Weiss, S. M., "Distributed Transmission Systems — Overcoming the Limitations of DTV Transmission" in NAB 2003 Broadcast Engineering Conference Proceedings, National Association of Broadcasters, Washington, DC, 2003.

service area. While the model of a main station providing the bulk of service will remain the core concept in television broadcast transmission, there are situations using digital transmission in which other models can produce better service to the public and better spectrum efficiency. For the FCC's purposes and for the remainder of these comments, distributed transmission can be defined as the use of more than one transmitter on a single frequency as part of a system to deliver a single signal to a service area.

The digital techniques used and enabled by the Commission's establishment of a Digital Television (DTV) service open a whole range of capabilities not envisioned by the Rules for analog service. So, too, the economics of data transmission through terrestrial fiber optic networks and other means to multiple transmission sites now enable transmission systems that can better reach viewers at costs that are reasonable for broadcasters to absorb. This economic situation has changed considerably in the last few years and sheds a new light on conclusions about distributed transmission reached by the FCC Advisory Committee on Advanced Television Service (ACATS) over a decade ago.

What makes distributed transmission possible is the fact that all digital television receivers, from the biggest integrated television sets to the smallest set top boxes, require a means for dealing with echoes ("ghosts," in NTSC terms). Echoes in received digital signals normally cause inter-symbol interference (ISI) that can make it impossible to properly interpret whether a received symbol represents one value or another. There are two primary methods for dealing with the echoes: (1) adaptive equalizers in the receivers, or (2) a particular form of modulation called orthogonal frequency division multiplexing (OFDM). In the 8-VSB system adopted by the Commission, the first method – use of adaptive equalizers – is universally applied.

When multiple transmitters are operated on the same frequency in proximity to one another, interference between them will naturally occur in some locations. Since digital receivers have the ability to handle echoes and since multiple signals arriving at a receiver from adjacent cells of a distributed transmission system are required to have precisely the same modulation on them, such signals will be treated as a series of echoes. The receiver will then adapt to the "echo" environment, extracting the correct data from the ISI-laden received signals. It is this echo elimination that really makes the distributed transmission / single-frequency network concept feasible.

The Commission has had inputs on the use of distributed transmission before. In the Memorandum Opinion and Order/Third Report and Order/Third Further Notice of Proposed Rulemaking released on October 16, 1992, the FCC specifically asked about such methods. In that Notice, the Commission indicated that it was awaiting the results of work undertaken in ACATS to help it decide how to deal with the matter.[3] The Advisory Committee, through its Implementation Subcommittee Working Party 2 (IS/WP-2) on Transition Scenarios studied the techniques and issued several reports. There was inadequate time as ACATS was winding down, however, for IS/WP-2 to prepare a complete report to the Commission on the subject. As a consequence, IS/WP-2 requested that a report be submitted to the FCC as individual comments by the leader of the Working Party's activities over its five-year life.[4] Subsequent to that report, a number of comments submitted in response to the Sixth Further Notice of Proposed Rulemaking[5] expressed concerns that stations should be able to use "boosters" in a manner that really amounts to distributed transmission as it will be defined shortly. Until the current proceeding, the Commission has not seen fit fully to address the matter.

Distributed transmission is a technique that can offer solutions to a number of difficult system design problems that often can be resolved in no other way. It has applications to reach blocked populations within a station's service area; this is especially important in hilly or mountainous terrain with large populations living in valleys. It can be useful when a station is unable to obtain sufficient tower capacity at an adequate height to reach the service area that has been allotted to it. It can be used when a station has started with a small service area and needs to maximize that service area without enlarging its central

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[3] In fact, the original submission to the FCC on the subject was included in the certification documentation submitted to the Advisory Committee in late 1991 by the American Television Alliance for the Channel Compatible DigiCipher (CC-DC) system, a 32-QAM modulation method. See also S.A. Lery, W.H. Paik, and R.M. Rast, "Extending HDTV Coverage Using Low Power Repeaters — A Cellular Approach," IEEE Transactions on Broadcasting, Vol. 38, No. 3, September 1992, pp. 145-150.

[4] See Comments of S. Merrill Weiss, Consultant, In the matter of Advanced Television Systems and Their Impact upon the Existing Television Broadcast Service, Memorandum Opinion and Order/Third Report and Order/Third Further Notice of Proposed Rulemaking, released October 16, 1992.

[5] See Sixth Further Notice of Proposed Rule Making, MM Docket No. 87-268, 11 FCC Rcd 10968 (1996).

facility. It is the only method that can allow relatively uniform signal levels to be achieved throughout a widely dispersed service area so as to enable, for example, reception using indoor antennas while at the same time not increasing interference to neighboring broadcasters. It can help with replication of NTSC service by DTV facilities that otherwise might not be able to achieve the coverage needed, especially in cases of VHF broadcasters moving to UHF channels.

The Commission should recognize that licensees are making long-term decisions and investments now. In order for stations to achieve the best possible results for the audiences that they serve, they should be enabled to use all the techniques that modern technology and the economics of the marketplace allow. This will best meet the Commission's goals of DTV delivery to the widest possible audience at the earliest possible time. It will also help realize the Commission's other, oft-stated objective of DTV service maximization. Not having distributed transmission technology available for use now can lead to decisions that are expedient in the short term but sub-optimal in the long term.

Reponses to NPRM Questions

In the Notice of Proposed Rulemaking, the Commission has posed a number of questions to help it decide what policies to apply to a number of aspects of distributed transmission technology and implementation. The questions are divided into six major categories and are treated in six paragraphs in the NPRM. It will take many more than six paragraphs to respond to all the questions, but they are addressed in the following sections, the headings of which bear the numbers of the paragraphs in which the questions were raised.

Primary vs. Secondary Status (¶101)

The NPRM notes that the Commission has received comments suggesting that it should grant primary status to the multiple transmitters in distributed transmission systems and license them under Part 73 of the Rules, as opposed to treating them similarly to LPTV, translator, and booster stations. In that regard, the FCC asks six associated questions, each of which is addressed in the following subsections.

Implications of primary status for distributed transmitters

The Commission seeks comment on the implications of granting primary status to distributed transmitters and whether some categories of such transmitters should be licensed with primary status. Perhaps just as relevant is the question of the implications of not granting primary status to distributed transmitters when they are located within the areas and providing the coverage prescribed as part of a primary station's service.

The Commission recently has shown its concern with spectrum efficiency, as evidenced by the establishment of the Spectrum Policy Task Force and the tremendous amount of effort that went into its work from participants within and outside the Commission. The use of distributed transmission techniques by broadcasters has the potential to significantly advance the FCC's goals with respect to spectrum efficiency by enabling increased levels of service while at the same time maintaining the same or reducing the levels of interference. This is the very definition of improved spectrum efficiency.

One of the previously cited uses of distributed transmission is for service maximization by broadcasters. Currently, if broadcasters wish to maximize their services, they do so by the conventional approach of using increased transmitter power, higher antennas, or a combination of both. When they do so, the service they provide is protected by the Commission from future interference caused by other broadcasters. At the same time, broadcasters who so maximize their services create rings of interference around their transmitters with radii up to three or more times the radii of the areas to which they provide service.[6]

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[6] The ratios between the distances served and the distances at which interference will be caused can be illuminated by some examples derived using the FCC's TVFMFS program. TVFMFS is based on the charts of power and antenna height above average terrain (HAAT) versus field strength and distance in §73.699 Figures 9 through 10c.

For instance, at UHF, with maximum facilities of 1000 kW at an HAAT of 365 m, the distance to the F(50,90) 41 dBu noise limited contour of a DTV station is 103.1 km. The distance to the F(50,10) 26 dBu contour at which the station would cause 15 dB D/U interference to a neighboring DTV station is 310.0 km, a ratio of over 3:1. With maximum UHF facilities of 316 kW at 610 m HAAT, the DTV service contour is at 110.3 km, and the DTV interference contour is at 296.6 km, a ratio of almost 2.7:1. The distances to the F(50,10) 30 dBu interference contours at which 34 dB D/U ratios would result with respect to NTSC neighbors are 283.3 km and 272.3 km, respectively, for the two cases examined previously. The interference-to-service distance ratios with respect to NTSC are thus in the range of 2.75-to-2.5:1. (*cont'd.*)

If a broadcaster instead chooses to use distributed transmission methods, which will be shown subsequently to be more spectrally efficient than the conventional means of service maximization, then that broadcaster must know that it will be similarly protected in the expanded service area it establishes. If it cannot have such certainty, then there will be a strong disincentive for a station to invest in the more spectrally efficient method. Instead, it will be encouraged to use a higher transmitter power than it otherwise might, to put the antenna for that transmitter on a taller tower than it otherwise might use, and to cast its interference zone much farther than could be the case if it were encouraged to use the more spectrally efficient methods offered by distributed transmission.

Thus, if the Commission is serious about encouraging the improvement of spectrum efficiency, it must offer at least the same future interference protection to stations that maximize service through more spectrum efficient means as it offers to those that choose conventional maximization methods. So, the implication of not treating as primary distributed transmitters that meet the appropriate location and service requirements is that the Commission will forego the opportunity to obtain from broadcasters more efficient use of the spectrum. Rather, it will encourage the status quo, in which larger interference zones than are necessary continue to be expanded as broadcasters maximize their services. As discussed below in a policy sense and explained later from a technical standpoint, the Commission can encourage the routine use of more spectrally efficient distributed transmission techniques with relatively straightforward modifications of its Rules.

Impact of primary distributed transmitters on existing LPTVs and translators

The FCC has indicated a particular interest in the impact of primary distributed transmitters on existing, secondary LPTV and TV translator stations. It asks whether some protection should be afforded to these secondary stations. In addressing these

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For another instance, at High VHF, with maximum facilities of 160 kW at 305 m HAAT, the distance to the F(50,90) 36 dBu service contour is 116.6 km, while the F(50,10) 21 dBu contour resulting in 15 dB D/U interference to a DTV neighbor falls at 296.2 km, a ratio of 2.5:1. With maximum facilities of 30 kW and 610 m HAAT, the service contour is at 123.4 km, and the DTV interference contour is at 278.1 km, a ratio of over 2.25:1. For interference to NTSC neighbors, the distances to the F(50,10) 22 dBu contours are 289.9 km and 272.2 km, respectively, for the same two sets of maximum facilities, resulting in ratios of interference-to-service contour distances to NTSC neighbors in the range of 2.5-to-2.2:1.

interests, it is first necessary to recognize the existing relationships between full service DTV stations and the secondary operations. Under the current Rules, DTV stations can maximize their services without regard to any interference they may cause to secondary LPTV and translator stations. At least to the extent that a DTV broadcast station could maximize its facilities using a single, central transmitter, that situation should remain unchanged. Thus, at the very least, DTV facilities should be able to be maximized to the same extent, no matter which method – single transmitter or distributed transmission system – is used. If the Commission wishes to provide some amount of protection for secondary stations beyond this, it can adopt limits in the service areas covered by distributed transmitters based on the interference contours they are predicted to generate. Such limits can be attained by limiting the contour distances of distributed transmitters at the field strength levels that provide the desired protection ratios to secondary stations to the same contour distances that would be obtained from single transmitter maximization. This approach is discussed later in the subsection on Distributed Transmitter Service Areas.

Should the Commission decide that distributed transmitter service areas should be enabled to extend to the boundaries of the DMAs in which stations are located, then it follows that protection should not be accorded to secondary LPTV and translator stations within those DMAs. At first reading, this approach may seem harsher than it is in reality. It must be recognized that many translator stations, in particular, are used by broadcasters in order to serve portions of their DMAs that their main transmitters cannot reach. Thus, in allowing the increased spectrum efficiency that derives from DTV station reuse of the same spectrum to fill out service to a DMA, more spectrum will remain available for the relocation of those LPTV stations that are displaced by DTV station initial service or maximization. Indeed, discussions with broadcasters who use large numbers of translators, often in remote areas, has shown that the ability to serve their DMAs through use of distributed transmitters can reduce significantly the total number of channels they occupy. This reduction in spectrum occupancy will provide more opportunities for relocation of displaced secondary LPTV stations than would exist otherwise.

Impact of primary distributed transmitters on future LPTV and translator channels

The Commission has asked what impact authorization of primary distributed transmitters would have on the future availability of channels for secondary analog or digital LPTV or translator stations. As discussed previously with respect to the impact of primary status for distributed transmitters and to protection of existing LPTV and translator stations, the authorization of primary distributed transmitters will have the result of encouraging the use of more spectrum efficient methods by broadcasters. Improved spectrum efficiency translates to reduced interference and hence more available spectrum. Thus, by treating distributed transmitters as primary, the Commission will encourage the use of more spectrally efficient techniques and thereby make more spectrum available for other uses such as LPTV and translator stations. Moreover, by permitting broadcasters to maximize their services throughout their DMAs on the same channel, the number of translators competing for the available spectrum will be decreased significantly, making it easier to relocate displaced LPTV stations.

It should be noted that there are some rural portions of the country where vast networks of translators are used to provide service from the nearest cities. Situations of this sort generally use all available channels to provide service and to relay signals from area to area without interference between translator stations. In such cases, to enable the relay delivery of signals to distributed transmitters operating on the same channel as the main transmitter while avoiding the limitations of on-channel repeaters, it will be desirable to allow the use of an alternate channel at a relay point in the network. In such cases, it is highly recommended that the relay transmitters be treated as primary in the same way as the distributed transmitters that are filling out service to the DMA. This will enable complete networks to be built with the assurance that all elements are similarly accorded primary treatment. In such instances, limitations on the use of such primary relay stations are perfectly appropriate. Suggested limitations are that such stations must be used both to provide service to the public and to deliver signals to distributed transmitters in farther reaches of the network. Other limitations may also be appropriate. The net result would be to limit to two the total number of channels used by distributed transmission networks in such cases, as opposed to the many channels used today.

Importance of distributed transmitters in facilitating DTV transition

The Commission has inquired how important distributed transmission systems are likely to be in facilitating the transition to DTV. It is submitted that, absent distributed transmission, the DTV transition will not occur for a very long time in some areas. This result obtains from the facts that there are large parts of the country that DTV transmitters cannot reach, even after maximization, and that the signals of those DTV transmitters are unlikely to be carried on cable systems during the transition absent dual must carry for those stations. Thus, to enable DTV stations to reach the populations they otherwise would not be able to serve and thereby to provide sufficient numbers of services to entice the viewing public in those areas to obtain the necessary DTV receiving equipment, it is vitally important that the Commission authorize the use of distributed transmission methods.

Two examples can serve to illuminate the issue. In the population centers of Altoona, Johnstown, and State College, Pennsylvania, it is not possible to build a single transmitter facility to serve the entire market. Each major population center is located in a separate valley. A transmitter built to serve one of the communities will be cut off to a large extent from at least significant portions of the others. This is the reason that the first distributed transmission system authorized by the Commission, currently under an experimental license, is located in this market. Even using a maximized facility having the highest transmitter power allowed by the Rules, at the highest antenna elevation that can be achieved in the area, it is not possible with a single, central transmitter to reach the bulk of the market's population. Thus, multiple transmitters are required if the majority of the people in the area are to have off-air digital television reception available to them. Similarly, in the Reno, Nevada, market, it is not possible to provide service from a single transmitter to Reno and to Carson City, the state capital, which is located in the Reno market. The Commission has similarly authorized use of distributed transmission techniques to serve Carson City under an experimental license for an on-channel repeater until Rules are in place for routine authorization of the method. Without the use of a distributed transmitter, there would be no over-the-air DTV service to the Nevada state capital.

Essential nature of primary status to distributed transmission systems

The Commission asks whether primary status is an essential part of distributed transmission systems. From the foregoing, it should be apparent that primary status is essential if the benefits of spectrum efficiency offered by distributed transmission techniques are to be obtained. Without primary status of distributed transmitters, broadcasters will be encouraged to use single transmitters with maximized facilities so as to attain the largest protected service areas. They will use distributed transmission methods only where they must supplement their main transmitters because of terrain blockage or interference constraints. Without primary status of distributed transmitters, broadcasters will not be encouraged to use lower power transmitters and lower antenna elevations that result in smaller interference zones and thus leave more spectrum available for other uses outside their service areas. They consequently will not be able to provide the benefits to the public of more uniform and stronger signal levels within their service areas, and their signals therefore will not be as widely available as could be the case. Thus, it can be said that, while primary status is not technically required to allow operation of distributed transmitters, as a practical matter, if the spectrum efficiency benefits offered by the technique are to be achieved, primary status is essential to motivating the trade-offs by broadcasters attendant to their use.

Location and Service Area (¶102)

The Commission begins its questioning about the locations and service areas to be allowed when using distributed transmitters by pointing out the current Grade B contour limitations on analog TV boosters. It uses the analog situation as a point of reference for its inquiry, which is formulated into two questions.

Need for a contour limitation on distributed transmitter service area

The FCC inquires whether there should be an equivalent requirement for distributed transmitters as that imposed on analog boosters, with respect to which the service areas must be contained within the Grade B contours of the associated full service stations. It is submitted that such a limitation would preclude one of the main uses and benefits of distributed transmission techniques, namely, the ability to maximize service without causing increased interference to neighboring stations. While limitations on the locations and service areas of distributed transmitters are certainly appropriate, and such limitations are discussed in detail below, limitations placed on the contours of distributed transmitters to keep them within the contours of main stations would fail to recognize the difference adopted by the Commission between the administration of the analog and of the digital services.

In the analog service, contours are essentially the only method used to determine protection, and they serve an administrative purpose. The contours of stations are assumed to enclose areas with service, and the contours of stations are used to keep them sufficiently far apart that interference is assumed not to occur. In the digital service, contours serve only to limit where interference analyses are conducted, and their role is technical rather than administrative. Instead, the administrative limitation is derived from studies of interference to small areas within defined contours that are represented by points on a grid to which studies are conducted using terrain-based propagation models. The real administrative limitation is then calculated using the population impacted by interference at the respective representative grid points.

In the analog service, the contour was seen as the real limit of service and keeping contours inside other contours provided the desired interference limitations. In the digital service, in which maximization of service is an objective, use of a currently specified contour, such as the noise limited contour or the city grade contour, would be entirely too limiting in the placement and service of distributed transmitters. Instead, either the interference contours or the DMA boundaries should be used to provide the needed limitations, as described later, with a preference for the DMA method as being more representative of the areas to be served by stations.

Difference in requirements for primary vs. secondary distributed transmitters

In conjunction with its questions about the locations and service areas of distributed transmitters, the Commission has asked whether there should be different requirements for distributed transmitters, which would be accorded primary status, as opposed to DTV boosters, which would be secondary. Indeed, there should be differentiation made between distributed transmitters, which are part of a distributed transmission system, and DTV boosters, which are not. It is for this reason that these comments use different terms for the two types of stations that nonetheless use similar on-channel techniques. In the case of distributed transmitters, there are a number of additional technical requirements to assure that receivers can treat signals from multiple transmitters as echoes of one another, and there are limitations proposed on the locations and service areas of the transmitters. In the case of DTV boosters, the technical requirements can be less stringent, and there is no need to meet the location and service area limitations. These differences should be built into the Rules and should serve to separate distributed transmitters, which should be treated as primary and covered by Part 73 of the Rules, from DTV boosters, which should be treated as secondary and covered by Part 74 of the Rules.

Power, Antenna Height, and Emission Mask (¶103)

In asking about the parameters that should be allowed for use by distributed transmitters, the FCC raises four questions that relate to limitations of one sort or another. In most cases, the existing Rules for DTV stations can be applied directly to distributed transmitters with little or no modification.

Maximum or minimum limitations on distributed transmitter parameters

The Commission begins this part of its inquiry by asking what maximum or minimum limitations, if any, should be placed on the power and/or antenna height used at each distributed transmitter. Since each situation is different, and since distributed transmission systems will require the maximum in flexibility in order to achieve the best possible solutions, the fewer limitations the better with respect to operating parameters. Moreover, distributed transmitters and the networks in which they are situated will tend to be inherently limited by the need to meet interference requirements with respect to neighboring stations, as discussed in detail elsewhere. Thus, there is no reason that the limitations on the maximum power and antenna height of distributed transmitters should not be the same as those specified in §73.622(f)(5) of the Rules for main DTV stations. Similarly, there is no need for minimum limitations. If a station finds it appropriate to invest in installing a distributed transmitter that fits into its network of transmitters, then that should be sufficient. Moreover, the power levels of the transmitters in a distributed transmission network generally will be chosen to provide the appropriate D/U ratios between stations within the network in selected locations, thereby furthering the network design for internal interference mitigation. Putting unnecessary limitations on the design is inappropriate.

Limitation to power values specified for digital LPTV stations

The Commission questions whether distributed transmitters should be limited to the power values specified for digital LPTV stations. There is no reason to limit the power values to those specified for digital LPTV stations since the two types of stations are for different purposes and are intended to provide service to different types of areas. LPTV stations are intended to serve relatively small areas and to fit in the spectrum between full service operations. Distributed transmitters are intended to be part of the wide area services of full service stations, and there is no reason to force such stations to cover their service areas in arbitrarily small regions. They should have the flexibility in design of their networks to use cell sizes ranging from small to large depending upon the situations in which those networks will operate.

Emission mask requirements for distributed transmitters

The FCC asks in the NPRM what emission mask would be appropriate for distributed transmitters. Since the emission mask is generally intended to control interference radiated in adjacent channels, there is no reason that control of such radiation should be different from transmitters in distributed transmission networks than it should be from single transmitters. The exception to this might be very low power distributed transmitters that could be expected to serve very limited areas within a distributed transmission network. Such low power transmitters might be more likely to be used in such secondary services as DTV boosters, translators, and LPTV stations, but the same considerations should apply wherever they are used.

Categories of distributed transmitters requiring less strict mask performance

The Commission questions whether there are identifiable categories of distributed transmitters that could be allowed to meet less strict mask requirements. While these comments offer no evidence as to what the appropriate thresholds might be below which less strict mask requirements could be applied, it nevertheless is suggested that a threshold based either on the power output of the transmitter or on the effective radiated power of the facility would be the easiest approach to administer. Alternatively, a threshold based upon a combination of transmitter power and antenna height or upon the farthest distance to a specified contour could be used as a threshold to account for the overall interference-causing capability of the facility.

Interference Protection (¶104)

The Commission raises a series of four questions regarding the interference protection to be afforded to distributed transmission networks and from them to neighboring stations. Its questions also concern the aggregation of service areas and signal powers in performing the necessary analyses.

Standards to protect distributed transmission systems and their calculation

The Commission asks what standards are needed to protect distributed transmission systems from interference and how those standards should be calculated and applied. As discussed in detail later, the standards applied to interference protection to distributed transmission systems should be the same as those applied to single-transmitter operations, namely the *de minimis* limits of 2 percent reduction in population as compared to the baseline population established in Appendix B of the 6th Report and Order, as amended, with a maximum of 10 percent reduction from all interfering stations. The limits and the methods for determining them are spelled out in OET Bulletin No. 69 and in the Additional Application Processing Guidelines for Digital Television contained in Public Notice PNMM8116. The calculation of interference should be carried out in the same way as is done currently for single-transmitter stations with the exception that the service areas of the distributed transmitters should be aggregated, as discussed below, in order to avoid double counting of interference to the protected stations. The methods to be used to achieve these results are discussed in detail in a later subsection.

Protection to individual or aggregated distributed transmitter service areas

The next question in the NPRM asks whether interference protection should accrue to each distributed transmitter's service area or to the aggregate service area from all distributed transmitters. In order correctly to determine the population lost by a distributed transmission network to interference from a neighboring station, it is necessary to aggregate the service areas of the multiple distributed transmitters in the distributed transmission network. Since many locations can be within the service areas of more than one distributed transmitter, if each distributed transmitter's service area were independently analyzed for interference, the result could be counting the same population as lost from the service areas of several transmitters, i.e., multiple counting. To avoid this problem and provide a fair count of the interference caused to a distributed transmission network by a neighbor, it is necessary to treat the overall service area of the distributed transmission network as a whole. Detailed methods for such treatment are described in a subsection below. They result in determining whether at least one distributed transmitter can provide an adequate signal level without predicted interference to each grid point studied within the network service area. If so, the population represented by a grid point is counted as being served and is not counted as receiving interference. If adequate signal level is delivered to the grid point but interference is found with respect to all distributed transmitters at that point, then the population represented by the grid point is counted as receiving interference. This process results in the same treatment as would have been the case if a station maximized its service through use of a single transmitter.

Standards to protect other stations and their calculation

The NPRM goes on to ask what standards are needed to protect other stations from interference from distributed transmitters in a distributed transmission system and how those standards should be calculated and applied. Again, the basis for the standards to be used should be those found in the existing Rules and in related documents such as OET

Bulletin No. 69 and the Public Notice on Additional Application Processing Guidelines for Digital Television. Once again, the *de minimis* limits should apply, and the methods used should be those that make the analysis of interference from distributed transmission networks comparable to the analysis of interference from single transmitters. Details of how to accomplish this objective are discussed in the latter part of these comments. The fundamental approach is to properly combine the received signal powers from the several transmitters in a distributed transmission network at the receiver assumed at each grid point studied for interference within the service area of each neighboring station. Two methods for performing the necessary aggregation of signals are offered.

Aggregation of interference from distributed transmitters

The Commission completes the paragraph inquiring about interference protection by asking whether interfering signals from distributed transmitters should be aggregated and, if so, how. The answer to this question is yes; the signals from the multiple distributed transmitters in a distributed transmission network must be aggregated in the analysis of interference in order fairly to protect neighboring stations. The aggregation can take place in one of two ways: either distributed transmitters can be allowed to mask one another, as is the case with unrelated stations when analyzed using the current algorithm, or the signal powers from the several distributed transmitters can be appropriately added at each grid point studied within the service areas of neighboring stations. Since the signals from the transmitters in a distributed transmission system are coherent with one another, it might be assumed that they should be added together to determine the extent of their joint interference to a neighbor. But the coherence only exists for a receiver tuning to the signals from the distributed transmission network. For receivers tuning to another station, any signals from the distributed transmission network arriving at those receivers more than one symbol time apart (i.e., separated by more than 92.9 ns – equal to a path length difference of about 28 meters) will be incoherent to those receivers. Thus it could be argued that the multiple signals are no different in the interference they might cause than those of multiple neighboring stations.

In the end, whether to aggregate the interfering signals from distributed transmitters in a network must depend upon how conservative the Commission wishes to be in affording protection to neighboring stations versus how much it may wish to enable greater service by distributed transmission networks. If it wishes to be conservative regarding interference to neighbors, it will choose to aggregate the received signal powers, as described elsewhere herein. If it wishes to enable the maximum service from distributed transmission networks, it will recognize that the likelihood is very small of signals from two transmitters in a network arriving within 93 ns of one another at a receiver in an adjoining station's service area. In this case, it will allow the signals from the distributed transmitters in a network to mask one another, thereby somewhat simplifying the calculation of interference. Other alternatives intermediate between the two extremes presented may also exist and could be explored.

Technical Standards (¶105)

The NPRM contains a paragraph that inquires about technical standards for distributed transmitters as distinct from the requirements for single DTV transmitters. In response, it is proposed that the Rules for technical standards for distributed transmitters should be no different from those for single transmitters so as to minimize an unnecessary burden on broadcasters in implementing systems using them. There will be increased requirements on such transmitters to make them operate properly in networks, but the impact of those requirements is on the performance obtained within the service area of the network. It is posited that a broadcaster's interest in obtaining the best results from its network, which will directly affect the number of viewers who can receive its signal, will be sufficient to drive the broadcaster to do what is necessary to make the network work properly and well. It should be unnecessary for the Commission to add additional requirements that are unrelated to interference protection to neighboring stations.

Appropriate technical standards for distributed transmitters

The first specific question about technical standards asks what standards would be appropriate for distributed transmitters in distributed transmission systems with respect to specific technical requirements such as frequency tolerance, type certification of transmitters, control circuitry, and performance measurements. The issues raised basically relate to the interrelationships of the several transmitters in a network.

There is an ATSC standard currently in the approval process that covers essentially all the matters raised by the Commission in its question.[7] In order to provide the maximum flexibility in the implementation of distributed transmission networks, it is proposed that distributed transmitters follow the industry standard rather than there being any particular FCC Rules covering effectively the same characteristics. This is especially advisable since the performance of a distributed transmission network is dependent upon equipment and settings other than just those resident in a particular distributed transmitter. For example, a distributed transmission system includes a distributed transmission adapter that is interposed between the service multiplexer of a station and its studio-to-transmitter link (STL). The distributed transmission adapter inserts synchronizing information into the data stream that allows all the transmitters in the network to produce the same symbols on their outputs for the same data on their inputs. The distributed transmission adapter also sends control information to the several transmitters to establish the relative emission timing between them and various other characteristics.

The ATSC candidate standard provides for a frequency tolerance of ±½ Hz for each transmitter from the nominal frequency of the network. This keeps all transmitters within ±1 Hz of one another and thereby reduces the apparent Doppler shift seen by receivers in their treatment of the signal from one transmitter as the echo of another. The distributed transmission adapter stabilizes the data stream feeding the multiple transmitters through the STL so that the ±½ Hz tolerance and the ±1 Hz maximum differential can be maintained even under transient conditions of the transport stream data rate. As can be seen, there are many factors involved in establishing and maintaining a distributed transmission network, and it is suggested that the complexity is beyond what would make good sense for incorporation into specific FCC Rules. Rather, the industry standard should be permitted to establish the requirements for operation of distributed transmission networks.

With respect to type certification, if the Commission wished to have some assurance that transmitters to be used in distributed transmission networks would operate according to

[7] See ATSC CS/110, Transmitter Synchronization Standard for Distributed Transmission, available from www.atsc.org/standards/cs_documents/cs_110a.pdf.

the ATSC standard, it could require certification of compliance with that standard. Without such Commission action, however, it is nevertheless expected that transmitter manufacturers will follow the ATSC standard and will indicate their compliance with it in the specifications of their equipment that they provide to their customers.

Need for specification of technical parameters to assure performance

The Commission asks next whether technical and operational parameters must be specified to assure that a distributed transmission system performs properly. The answer to this question is yes, that technical and operational parameters must be specified to assure that a distributed transmission system performs properly, but not by the FCC. The industry standard now in the approval process within the ATSC is sufficient to assure that broadcasters have the tools to make distributed transmission systems operate correctly. It should also be recognized that it will be desirable to have some of the operational parameters of distributed transmission systems change over time and that building them into specifications enforced by the Commission would be counter-productive. In particular, the relative emission timing of the transmitters in the network may be adjusted as broadcasters learn more about the specific propagation conditions in their service areas, as they add distributed transmitters to their networks over time, and as receivers in consumers' hands become more capable of dealing with the stresses that distributed transmission systems could place on them. Thus, it is respectfully suggested that the operational parameters upon which the FCC should focus its attention are those that could cause interference to neighboring stations, as has been addressed at length elsewhere in these comments.

Transmission standards for distributed transmission systems

The NPRM then inquires what transmission standards should be set for distributed transmission systems and how and when such standards should be developed, tested, and implemented. With regard to the technology covered by the ATSC candidate standard previously referenced, the standards are already well documented by the ATSC, have been tested, and are already implemented sufficiently to show that they work. Indeed, they have been demonstrated publicly this year at the annual meeting of the ATSC and at the National Association of Broadcasters (NAB) convention. Within weeks of the due date for these comments, they will be in actual daily operation in the system authorized by the FCC under experimental license to WPSX-DT, the digital television facilities of the Pennsylvania State University, licensed to Clearfield, PA.

Appropriate benchmarks for performance plus measurement and monitoring

Finally in this section, the FCC inquires in the NPRM what benchmarks are appropriate to determine that a distributed transmission system is performing as designed and what monitoring and measurement equipment and procedures are necessary in order to test, adjust, and maintain distributed transmission system equipment in proper operating order. There are a number of adjustments of distributed transmission systems that it is proposed that broadcasters be permitted to make to their networks without the related parameters being specified in licenses by the Commission. Foremost among these, as previously discussed, is the relative emission timing of the various distributed transmitters. As also discussed above, it may also be beneficial to allow the adjustment of power levels to optimize the network.

In such cases, the benchmark for network adjustment will be the relative signal timing and levels as measured at significant locations within the service area of the network. Those locations will be at places where the signal level ratios between transmitters will cause operation of the adaptive equalizers in receivers so as properly to recover the data in the signals. To permit measurements to be made of the signal levels and timing of the individual transmitters in a network, the ATSC standard includes provision for inclusion of an RF Watermark signal in all distributed transmitter outputs. The RF Watermark is completely described in the ATSC document, but, in short, it allows identification of the signals, their received signal levels, and their relative time relationships for all the distributed transmitters received at any location. This provides all the information needed to permit adjustment and monitoring of the network.

The RF Watermark has a number of features that may make it of interest to the Commission for other purposes. It is a form of buried spread spectrum signal that can be detected and from which information can be retrieved even when it is over 50 dB below the level of other signals in the same channel. It is designed to allow the identification of signals from distributed transmitters when they are 20 dB lower in level than the signals from other transmitters in the network. This is approximately the point at which receiver adaptive equalizers begin to work. The RF Watermark is designed to operate at levels on the order of 30 dB below the level of the main 8-VSB signal carrying it. This allows it to ride along with the main signal without causing significant performance degradations in receivers. Under these conditions, it carries unique identification information for each transmitter and can allow recovery of the channel impulse response for each transmitter at any location where it can be received.

When the day comes that many high power DTV signals are on the air in the television broadcast spectrum, it may be useful to use the RF Watermark technology as a way to determine the source of co-channel interference. Currently, when there is NTSC interference, there is the opportunity to determine the source by observing the station identification of the weak signal in the background of the station receiving interference. Such a method is not possible with digital signals. But an RF Watermark could be recovered from interfering signals at a level lower than the threshold at which they begin to cause interference. Thus it offers the future potential to help in sorting out co-channel interference due to propagation anomalies. Since the RF Watermark is normally transmitted below the maximum noise level of DTV transmitters, as specified in ATSC recommendations, it is believed not to require FCC authorization for its use. Nevertheless, the Commission may wish to consider its use in the future for transmitter identification purposes beyond those needed to adjust and maintain distributed transmission systems.

General Matters (¶106)

The section of the NPRM on distributed transmission technologies concludes with a paragraph asking general questions concerning authorization of routine deployment of distributed transmission networks and on the supporting administrative structures that will be needed to enable their use. These are treated as two separate topics below.

Commission authorization of distributed transmission system deployment

The Commission seeks comment generally on whether it should permit the deployment of distributed transmission systems. To this, we respond emphatically yes; the Commission should permit the routine deployment of distributed transmission systems as soon as the necessary changes in the Rules and the supporting processing methods and software modifications can be put into place. There are broadcasters who need the tools of distributed transmission made available to them now. They have difficult coverage or service problems that can be solved in no other way. Giving them the tools to allow DTV to solve problems for them will encourage their development of their digital operations and further the Commission's objectives for a speedy transition to digital operation by all broadcasters. It will enable more of the viewing public to receive digital television service over the air than could do so absent use of distributed transmission techniques. It will enable broadcasters to deliver signals to cable headends when cable operators are willing to carry the digital signals, and it will enable broadcasters to reach viewers set top antennas directly when cable operators will not carry the digital signals. Moreover, even when cable is connected to viewers' homes, there are often television sets for secondary and tertiary applications within those homes that are not connected to the cable. They have historically gotten their signals over the air. Distributed transmission can help that form of delivery to continue in the digital age by making set top reception practical over a wider portion of broadcasters' service areas.

Relevant rules, policies, forms, and procedures to enable routine authorization

Finally, the Commission asks that commenters specifically address the relevant rules and policies that would have to be put in place to permit distributed transmission systems and any new or amended forms, policies, and/or procedures that would be needed with respect to the Commission's current system for filing, processing, and granting television station licenses.

There are anticipated to be four aspects to the Commission's administration of distributed transmission systems. First, a rule must be promulgated in Part 73 permitting broadcasters to license more than one transmitter on their assigned channel and specifying the conditions and limitations under which additional transmitters can be licensed. Earlier parts of these comments have dealt with the limitations on locations and service areas and with the operational characteristics and parameters that should be permitted to such transmitters. Other portions of these comments have dealt with the interference aspects of the authorization of distributed transmitters. All of these elements should be specified in the new rule, and suggestions are given both above and below about how they should be handled, even though they are not repeated here.

Second, the interference analysis methods to be used in conjunction with distributed transmission systems must be codified and the necessary adjustments made in the processing software used by the Commission and others. The codification is anticipated to take the form of an OET Bulletin similar to OET Bulletin No. 69, which codified the methods for DTV interference analysis in the first instance, or some alternative document from the Commission. The adjustments in software would be made to the Commission's TV_Process program, which is used by the staff in the analysis of all television broadcast applications and a version of which also is used by many industry consultants and others in preparing applications for filing. As before, publication of the Commission's software is expected.

Third, a small number of changes will be needed in the application forms used for obtaining construction permits for DTV facilities and in the Commission's record keeping and CDBS database. It is assumed that the Commission will continue to use the forms now used for applications for individual transmitters rather than instituting a new form to cover a complete distributed transmission network. Under this assumption, among the changes needed in the forms will be a way to indicate that an application is for a transmitter in a distributed transmission system, to associate the transmitter with the distributed transmission system, and perhaps to certify that the transmitter covered by the application is located within the limitations allowed for the particular distributed transmission network. There may need to be a means to indicate which of the several transmitters in a distributed transmission network is to be considered the reference for laying out the grid of points used for interference studies in the processing software. The CDBS database will have to be modified to the extent of adding one field to records to allow capturing the association between transmitters in a distributed transmission network and perhaps to indicate which of them is the reference for interference analysis purposes. Ideally, the field would carry a number that would serve as the network identifier portion of the RF Watermark signal and that would be uniquely assigned by the Commission, and it would carry the individual transmitter identifier discussed in the next paragraph.

Fourth, the Commission will also have to decide how to assign or apply call signs to the transmitters in a distributed transmission network. By virtue of the fact that all the transmitters in a network must transmit the same 8-VSB symbols at basically the same time for there to be a coherent signal for receivers, it will not be possible for transmitters to identify themselves separately other than through use of the RF Watermark. Consequently, it would make sense for all of the transmitters in a network to operate under the same call sign, which would be given over all the transmitters in the network in whatever way is required for single-transmitter stations. Nevertheless, it might be useful for the transmitters to have assigned to them a hyphen followed by a hexadecimal number after the call sign of the station. This would directly relate to the number that will be carried by the transmitter identifier portion of the RF Watermark data. The RF Watermark can accommodate up to 4096 such transmitter identifiers in a single network, each represented as a three-character hexadecimal number. Alternatively, decimal notation could be used in the Commission's records, which would be converted to hexadecimal (i.e., binary) form for transmission in the RF Watermark.

Definition and Benefits of Distributed Transmission

The remainder of these comments provides additional explanation of and justification for distributed transmission and more technical information to help in its evaluation and the preparation of appropriate rules. For sake of explanation, distributed transmission can be likened to a cellular telephone system. The service area is divided into a number of cells, each with its own transmitter. In some cases, the transmitter powers may be much lower than that of a single, central transmitter. Lower tower heights may also be used as compared to those required to cover a larger area from a single site. In many applications for distributed transmission, a large main station will be combined with distributed transmitters to fill in gaps in coverage or to maximize the service area.

The major difference between cellular telephone systems and distributed transmission is that cellular phone systems divide the spectrum into three or more channel groups, with individual cells using only one of the groups. Cells are assigned channel groups in a pattern that assures that no adjacent cells share the same channel group. In broadcast television transmission, there will be no additional channels available to establish such an alternating assignment pattern. Instead, there will have to be a single-frequency network (SFN), with all transmitters on the same frequency. It is to emphasize this difference that the term "distributed transmission" is used here instead of "cellular television."

As defined previously, distributed transmission is the use of more than one transmitter on a single frequency as part of a system to deliver a single signal to a service area. Use of on-channel repeaters, which receive signals over the air and relay them, can be treated as a subset of the distributed transmission concept. This definition leads to a number of issues, largely technical, that must be addressed in order to enable the use of the subject techniques, but it will inform the remainder of this discussion.

System Design Issues

For the distributed transmission concept to function, there are a number of prerequisites. Foremost among these is that all of the transmitters must produce identical signals, in the sense that they radiate the same symbol codes in the same order for the same data input. This keeps all of the signals coherent with one another so that to the receiver they appear as echoes of the same signal. This coherency allows desired-to-undesired, or D/U, signal level ratios between signals from the various transmitters to approach or reach 0 dB while still allowing receivers to recover the data the signals carry.

If the signals were not coherent, it would be necessary to treat them as true interfering signals, maintaining the required co-channel interference D/U ratios (on the order of 15-20 dB) between signals from multiple transmitters as seen by the receivers. Nevertheless, it helps to use terrain shielding between transmitters whenever possible, so as to minimize the burden on legacy receivers by reducing the strength of the apparent "echoes." This arguably will not be the case for future generations of receivers, some of which already have been demonstrated to work as well or better with echoes as without.

There are several other considerations about the ways in which distributed transmission systems are implemented that can have significant impacts on the benefits that can be derived from use of the technique. Certain characteristics of receivers also come into play in this context. Among the most important of the implementation aspects for transmission is the means used to feed signals to the transmitters. There are two fundamental methods: over-the-air by relaying from transmitter-to-transmitter, and using a separate delivery system. Separate delivery systems can include microwave channels, fiber optics, or even an alternate broadcast channel, the latter of which avoids the problems associated with localized feedback and permits digital processing techniques to be applied at each stage in the distribution network.

When normal over-the-air relaying is used, very little control is possible of the relative timing of the emission of the modulation symbols. The timing depends only on the physical separation of the transmitters one from another, the speed of radio wave propagation, and any delays through amplifiers, filters, and signal processing circuitry in the repeater receiver/transmitters. Another consideration with over-the-air relaying is that there are physical limits to the amount of power that can be transmitted because of the tendency of the receiving and transmitting antennas to couple signals. This antenna coupling leads to feedback, which will result in oscillation if too much gain is used to raise the transmitted power level and to signal distortion below the point of oscillation. It is also much more difficult to transmit a signal without noise from a transmitter that has received its input signal by relaying since the signals, once modulated, are fundamentally analog in nature, being interpreted back to bits in the receiver. Cleaning up the received signals will result in increased delays through on-channel repeaters, moving the relative timing of the signals in the wrong direction with respect to the stresses they put on receiver adaptive equalizers.

When a separate delivery system is used, which can include a separate broadcast channel used as an over-the-air digital relay, some transmitters can be delayed in their emissions in order effectively to advance the timing of others. Such adjustments, along with the spacing of the transmitters from one another, in turn, will impact the length of adaptive equalizers needed in receivers. Through adjusting the relative timing of the transmissions, it is possible to optimize the system so as to minimize the burden on receivers regarding the echoes they must correct or ignore. It is also possible to transmit signals with no noise addition from the delivery system. The power levels in such systems can be whatever is required to achieve the desired D/U ratios between transmitters. Typically, the locations of areas having low D/U ratios will be placed where there is relatively low population and thus fewer people to be affected by the interference internal to the network.

Benefits of Multiple Transmitters

A number of benefits accrue to the use of multiple transmitters to cover a service area. Among these are the ability to obtain more uniform signal levels throughout the area being served and the maintenance of higher average signal levels over that area. These results come from the fact that the average distance from any point within the service area to a transmitter is reduced. Reducing the distance also reduces the variability of the signal level with time and thereby reduces the required fade margin needed to maintain any particular level of reliability of service. These reductions, in turn, permit operation with less overall effective radiated power (ERP) and/or antenna height.

When transmitters can be operated at lower power levels and/or elevations, the interference they cause to their neighbors is reduced. Using multiple transmitters allows a station to provide significantly higher signal levels near the edge of its service area without causing the level of interference to its neighbor that would arise if the same signal levels were delivered from a single, central transmitter. The interference reductions come from the significantly smaller interference zones that surround transmitters that use relatively much lower power and/or antenna heights.

With the use of multiple transmitters comes the ability to overcome terrain limitations by filling in areas that would otherwise receive insufficient signal level. When the terrain limitations are caused by obstructions that isolate an area from another (perhaps the main) transmitter, advantage may be taken of the obstructions in the design of the network. The obstructions can serve to help isolate signals from different transmitters within the network, making it easier to control interference between the network's transmitters, as will be described below. When terrain obstructions are used in this way, it may be possible to place transmitters farther apart than if such obstructions were not utilized for isolation.

Where homes or apartments are illuminated by sufficiently strong signals from two or more transmitters, it may be possible to take advantage of the multiple signals to provide more reliable indoor reception. When a single transmitter is used, standing waves within a home sheathed in metal will result in areas within that home having signal levels too low to use. Signals arriving from different directions will enter the resonant cavity of the home through different ports (windows) and set up standing waves in different places. The result often may be that areas within the home receiving low signal levels from one transmitter will receive adequate signal levels from another transmitter, thereby making reliable reception possible in many more places within the home.

Limitations on Distributed Transmission Networks

While they have the potential to solve or at least ameliorate many of the challenges of RF transmission, distributed transmission networks also have limitations of their own. Foremost among these is the fact that there will be interference between the signals from the several transmitters in a network. This "system-internal" interference must be managed so as to bring it within the range of capabilities of the adaptive equalizers of the largest number of receivers possible. Where the interference falls outside the range that can be handled by a given adaptive equalizer, other measures, such as the use of outdoor directional antennas or perhaps future "smart" antennas, must be applied.

Adaptive Equalizer Considerations

The characteristics of adaptive equalizers that are important for distributed transmission network design are the ability to deal with multiple signals (echoes) with equal signal levels, the length of echo delay time before and after the main (strongest) signal that can be handled by the equalizer (or the total delay spread of echoes that can be handled when an equalizer design does not treat one of the signals as the main signal), and the interfering signal level below which adaptive equalizer operation is not needed because the interference is too low in level to prevent reception.

The last of these characteristics, which is somewhat lower in level than the co-channel interference threshold, determines the areas where the performance of the adaptive equalizer matters. In places with echo interference below the point at which the adaptive equalizer needs to correct the signal, it is not necessary in design of the distributed transmission network to consider the differential arrival times of the signals from the various transmitters. In places with echo interference above that threshold, the arrival times of the signals matter if the adaptive equalizer is to be able to correct for the echo interference. Differential delays between signals above the echo interference threshold must fall within the time window that the adaptive equalizer can correct.

Current receiver designs have fixed time windows inside which echoes can be equalized. The relative amplitudes of correctable echoes also are functions of their time displacements from the main signals. The closer together the signals are in time, the closer they can be in amplitude. The further apart they are in time, the lower in level the echoes must be for the equalizer to work. These relationships are improving dramatically in newer receiver front-end designs, and they can be expected to continue improving at least over the next several generations of designs. As they improve, limitations on distributed transmission network designs to accommodate receiver performance will be reduced.

The handling of signals with equal signal level echoes is a missing capability in early receiver front-end designs, but it is now recognized as necessary for receivers to work in many situations that occur naturally, without even considering generation of such echoes in distributed transmission networks. The reason for this is that anytime there is no direct path or line-of-sight from the transmitter to the receiver, the receiver will receive all of its input energy from reflections of one sort or another. When this happens, there may be a number of signals (echoes) arriving at the receiver that are about equal in amplitude, and they may vary over time, with the strongest one changing from time-to-time. This is called a Rayleigh channel when it occurs, and it is now recognized that Rayleigh channels are more prevalent than once thought. For example, they often exist in city canyons and mid-rise areas, they exist behind hills, and so on. They also exist in many indoor situations. If receivers are to deal with these cases, adaptive equalizers will have to be designed to handle them. Thus distributed transmission networks will be able to take advantage of receiver capabilities that are needed in normal circumstances.

Radio frequency signals travel at a speed of about $^{3}/_{16}$-mile per microsecond. Another way to express the same relationship is that radio frequency signals travel a mile in about $5^{1}/_{3}$ microseconds. If a pair of transmitters emits the same signal simultaneously and a receiver is located equidistant from the two transmitters, the signals will arrive at the receiver simultaneously. If the receiver is not equidistant from the transmitters, the arrival times of the signals from the two transmitters at the receiver will differ by $5^{1}/_{3}$ microseconds for each mile of difference in path length. In designing the network, the determination of the sizes of the cells and the related spacing of the transmitters will be dependent on this relationship between time and distance and on the delay spread capability of the receiver adaptive equalizer.

Because receivers have limited delay-spread capability, there is a corresponding limit on the sizes of cells and spacing of transmitters in distributed transmission networks. As receiver front-end technology improves over time, this limitation can be expected to be relaxed. As the limitation on cell sizes is relaxed and cells become larger, it can be helpful to network design to adjust the relative emission times of the transmitters in the network. This allows putting the locus of equidistant points from various transmitters where needed to maximize the audience reached and to minimize internal interference within the network. When such time offsets are used, it becomes desirable to be able to measure the arrival times at receiving locations of the signals from the transmitters in the network. Such measurements can be difficult since the transmitters are intentionally transmitting exactly the same signals in order to allow receivers to treat them as echoes of one another. Somehow the transmitters have to be differentiated from one another if their respective contributions to the aggregate signal received at any location are to be determined. To aid in the identification of individual transmitters in a network, a buried spread spectrum pseudorandom "RF Watermark" signal is included in the ATSC Candidate Standard, as described in detail below.

Adjacent Channel Issues

While distributed transmission techniques offer solutions to a number of signal delivery issues that broadcasters face, they should not be considered a panacea. There are certain circumstances in which they will not be usable because of the regional spectrum usage environment in which they might otherwise exist. For example, the allotment of adjacent channels in the same market can have the effect of precluding their use under certain conditions. One of the most significant of these circumstances is the presence of an NTSC station on an adjacent channel or, indeed, within four channels above or below that of a station seeking to apply distributed transmission methods. Given the requirements for interference protection embodied in OET Bulletin No. 69 and in §73.623(c)(2) of the Rules, it may not be possible to build distributed transmitters on channels having analog neighbors with such channel relationships. This results from the fact that in the area immediately surrounding any transmitter, there will be a very low D/U ratio with respect to stations that are not collocated. This will make it difficult or impossible to locate distributed transmitters in areas served by such adjacent channel and near adjacent channel neighbors unless collocation of the analog transmitters and the digital distributed transmitters can be arranged.

When neighboring stations are digital, less of a limitation on use of distributed transmission occurs since only the first adjacent channels are considered. Where there are neighbors on first adjacent channels, the use of distributed transmission techniques can be precluded for the same reasons as given with respect to analog adjacencies. This limitation can be overcome where the stations are willing to work together to build their distributed transmission networks in such a way that their transmitters are collocated with one another. Since there are increased economies of scale that can be achieved through cooperative development of distributed transmission networks, it is not unreasonable to believe that stations may coordinate their development of such systems in the future and indeed collocate their distributed transmitters. In any event, the provisions of the Rules regarding interference protection to adjacent channel and near adjacent channel neighbors will determine what is possible and what is not.

Technical Details to Support FCC Decisions

In the responses to the Commission's questions above, additional technical details were promised in a later portion of these comments. Those details are provided in this section. They focus on two major topics: geography and interference. Two subsections on geography deal with where distributed transmitters may be located and the regions they may serve. Two subsections on interference address the nature of interference relationships that must be considered when introducing distributed transmission systems and the interference analysis methods that should be used in determining whether interference is predicted in specific cases.

Distributed transmitter locations

Distributed transmitters can be used as part of distributed transmission systems for purposes including filling in service within previously defined contours, maximizing service by reaching new areas, and creating stronger and/or more uniform signal levels within a station's service area. These are the cases in which distributed transmitters should be treated as part of primary facilities. When used for such applications, it is necessary to appropriately define both the locations in which distributed transmitters can be placed and the service areas of stations with which distributed transmitters are so used.

Two alternative approaches to defining the locations of distributed transmitters and the service area of a distributed transmission system will be presented. The first builds on the signal contour methods that have been in use for analog television since its inception. The second recognizes the Designated Market Area (DMA) as the area actually being served by the stations in a market and controls distributed transmitter placement and service accordingly. The latter approach would be in keeping with the discussion in the NPRM that recognizes the possibility of determining the end of the DTV transition in each market based upon the market as defined by the DMA.[8] Should the Commission conclude that the appropriate market in which the end of the transition should be assessed is the DMA, then it only makes sense to permit broadcasters to expand their services to cover as completely as they are able the DMAs in which they are located. Distributed transmission can achieve such a result in cases in which a single transmitter may be unable to reach the farthest extremities of a geographically large DMA.

When evaluating the contour approach, there are two cases that must be considered in determining where distributed transmitters can be located. First, there is the situation in which a station uses its reference transmitter site, as contained in the original DTV Table of Allotments ("DTV Plan") as amended, for its main transmitter location. Second, there is the situation in which a station establishes a main transmitter location at a substantial distance from the original reference transmitter site. In the latter case, it is assumed that the new transmitter site, at least through maximization, is capable of meeting any criteria that may be established for service replication in terms of reaching the NTSC Grade B contour or the population within the station's NTSC Noise Limited contour.

In the case of a station that uses its original DTV Plan reference transmitter site, the distributed transmitters should be located within either the noise limited contour of its original reference facilities as included in the DTV Table of Allotments or its expanded noise limited contour as obtained through theoretical maximization of its facilities. The appropriate contour is whichever extends farther in the direction of the distributed transmitter from the reference location. The extent of theoretical maximization could be determined by assuming the limits in the Rules on facilities for the site at which the reference transmitter is located. Since distributed transmitters can be configured to operate closer to neighboring stations without causing interference than can be higher power stations on taller towers, it may be appropriate to determine the theoretical maximization for this purpose without reference to the interference that might be caused. Instead, just the contour in which distributed transmitters must be located would be determined.

[8] NPRM at ¶72-77.

In the case of a station that has established a main transmitter location different from its reference DTV Plan facilities but providing full replication of either its NTSC facilities or its reference DTV facilities, the distributed transmitters should be located within the outer boundary of the combined noise limited contour of its reference facilities and noise limited contour of its moved facilities. This is comparable to the use of the maximized contour in the previous case and allows service to be offered to populations within its NTSC Noise Limited contour that might otherwise be outside the service contour of the moved facilities. It would allow increasing the percentage of replication. It might also be useful to permit stations with moved facilities to maximize in the same way as described previously for stations at their DTV Plan reference sites in order to establish a contour within which distributed transmitters must be located.

In evaluating the DMA-based approach, it would be recognized that stations often are serving a larger area than can be covered from a single transmitter location. This is frequently the case in rural parts of the country. In an approach limited by the DMA boundaries, distributed transmitters would have to be positioned within the DMA in which the station was located. There are further limitations on where distributed transmitters could be positioned within the DMA, just as there would be limitations within the contours discussed previously, that arise from some of the other constraints considered in the following sections.

Distributed transmitter service areas

Once distributed transmitters are located within the appropriate noise limited contours or DMA boundaries, as described immediately above, then it is necessary to define the areas they are permitted to serve. This ultimately has implications for the technical parameters to which they can be designed. Service from distributed transmitters can be defined in two ways: in terms of the noise-limited or other contours they produce and in terms of the populations they reach as indicated typically by a terrain sensitive (e.g., Longley-Rice) type of analysis. In the case of defining service for purposes of limiting the facilities to a suitable level, the noise-limited contour may be the correct method as it is the same as used elsewhere for the same purpose. In the case of defining service for interference analysis purposes, then the Longley-Rice (or comparable) analysis is the correct method for similar reasons. There may also be some situations in which a Longley-Rice analysis plus a determination of population served in certain areas may be appropriate.

For the purpose of defining the permitted service from distributed transmitters, it should first be understood that the noise limited contours from distributed transmitters situated as defined in the previous subsection will extend beyond the noise limited contours of the reference or maximized facilities. The question then becomes by how much distributed transmitters located near the edges of service areas should be permitted to extend those service areas. It is submitted that a distributed transmitter should be permitted to extend by 50 percent the distance from the original or moved reference location to the farthest contour used to define permissible locations for distributed transmitters in the direction of the extension. The reference locations intended for this purpose are the original reference site from the DTV Table of Allotments in the first case described previously and the moved reference site in the second case.

Another way to look at limitations of permitted service from distributed transmitters is to optimize spectrum efficiency through their use. In this case, the objective would be to permit as much service area as possible without expanding the area of interference. This approach would be congruent with a concern for protection to LPTV, Class A, and other low power operations, as will be discussed subsequently. In such a case, the interference contour of a theoretical maximized facility would be established. The interference contour would be determined using the FCC's F(50,10) propagation curves or equivalent methods. The signal level of the contour controlled could be any of four possible choices. These include as possibilities: (1) the digital-to-analog full service contour based upon a D/U ratio of 34 dB and Grade B service signal level of 64 dBu, resulting in control of the 30 dBu contour; (2) the digital-to-digital full service contour based upon a D/U ratio of 15 dB and a noise limited signal level of 41 dBu, resulting in control of the 26 dBu contour; (3) the digital-to-analog low power contour based upon a D/U ratio of 34 dB and a protected service signal level of 74 dBu, thereby resulting in control of the 40 dBu contour; or (4) the digital-to-digital low power contour based again upon a D/U ratio of 15 dB and a protected service signal level of 51 dBu, thus resulting in control of the 36 dBu contour. Arguments could be made for and against selection of each of the controlled contour levels, but whichever one were chosen, the result would be to permit maximum use of the spectrum within the service area of the distributed transmission system while eliminating the extension of interference outside the service area beyond that which would be caused by a conventionally maximized facility.

While it is proposed that the noise-limited contours of the reference facilities not serve as an absolute limitation on the area to be served, it is nonetheless necessary to avoid a situation in which stations can overly extend their services into adjacent markets. This is in keeping with prior FCC decisions about the purposes for which station relocations would be permitted. Thus, it may be desirable to place an additional limitation on the service that can be provided by distributed transmitters, taking into account the population served and where that population is located. One way to achieve such a result would be to place a limit on the population served by a distributed transmitter so that at least, for example, 50 percent of any new population (i.e., population not reached from the theoretical maximized facilities) reached by a distributed transmitter must be within the DMA in which the station is located. The same limitation could be applied if the Commission selected a DMA-based limitation on distributed transmitter locations. Thus, distributed transmitters likely would be prevented from being located right on the noise-limited contours of the theoretical maximized facilities or right on the DMA boundaries and would be pushed back somewhat from those limits in order to control where the populations to be served would be located.

Interference considerations

Interference considerations with respect to distributed transmission systems must deal with both directions. That is, interference must be analyzed from distributed transmission systems into neighboring systems and from neighboring systems into distributed transmission systems. Analysis of the interference to neighbors is a fairly straightforward modification of the process already in place, while analysis of the interference from neighbors requires a bit more modification of the existing processes but is based on them nonetheless. In both cases, the Commission's Longley-Rice analysis procedures as spelled out in OET Bulletin Number 69 and the *de minimis* limitation criteria are proposed to be retained.

Regarding interference protection to neighbors, it is necessary to assure that the distributed transmission system causes no more than the allowed 2 percent reduction in population served by a neighboring station, with a total of no more than 10 percent reduction by all stations. The distributed transmission system to be analyzed comprises the main transmitter and all distributed transmitters. To analyze the impact of the distributed transmission system on a neighbor, the neighbor's service is analyzed in two ways. First the neighbor is analyzed with the reference facilities of the station under study from the amended original Table of Allotments included in the analysis and the distributed transmission system not included. Then the neighbor is analyzed in reverse fashion, with all the transmitters of the proposed distributed transmission system included and the reference facilities from the amended original Table of Allotments not included (unless they are also included as part of the distributed transmission system's design). The two analyses are compared in the same way as normally done for single-transmitter stations and a determination made about the meeting of the *de minimis* criteria. This process can be implemented with existing software that has been developed for interference analysis of conventional situations.

For interference protection from neighbors to distributed transmission systems, it is necessary to measure the *de minimis* impact of the neighbors on the system as a whole. To do so requires recognition that a given location within the distributed transmission system's service area may be served by more than one transmitter. An interfering station could conceivably deliver a strong enough signal to a particular location to interfere with the signals from several of the transmitters in the distributed transmission system. If each transmitter in the system were analyzed individually, double counting of interference losses would result. To avoid double counting, it is necessary to analyze the neighbor's interference so that interference to any particular location is not considered to occur if any of the distributed transmission system's transmitters can deliver a signal to that location with an adequate D/U. Even when none of the transmitters in the distributed transmission system can deliver a signal with an adequate D/U ratio to a particular location, that location should only be counted once in accumulating the population losses for the *de minimis* calculation. To accomplish this avoidance of double counting, it is necessary to lay down a single grid of analysis cells, as used in the Longley-Rice method of OET-69, to determine the interference to all of the transmitters in the distributed transmission system. The cells would be laid out based upon the reference point for the entire system – either the main transmitter or the reference coordinates from the amended original Table of Allotments. Distributed transmitters would have to be linked to the system in the FCC database so that interference analysis computer software could identify all the elements in a system. Discussion of this matter with the supplier of the Commission's software for such analyses (who also supplies this commenter with similar software) indicates that the modifications just described can be made to the existing software as an extension and without requiring a major overhaul of the program.

One other form of interference requires recognition in deciding how to analyze interference from neighbors. That is the interference that occurs within the system between transmitters that are part of the system. It will occur if all that is considered are D/U ratios. As discussed previously, however, there are several techniques that can be used to mitigate such internal interference. They include timing of the transmitters' emissions to take advantage of receiver characteristics, use of terrain shielding, and the like. Application of such mitigation techniques may improve over time as a system is better understood and adjusted. For purposes of the interference analysis from neighbors, internal interference within a system should be ignored, i.e. treated as though it does not exist, when calculating meeting of the *de minimis* limits.

Interference Analysis Methods

When considering the interference analysis methods required to treat use of distributed transmission techniques, there are three fundamental cases that must be analyzed. The first of these is interference from a distributed transmission network to a single-transmitter station on the same or an adjacent channel. The second is interference from a single-transmitter station on the same or an adjacent channel to the distributed transmission network. The third is interference between distributed transmission networks and is, in reality, a combination of the first two cases in its solution.

Interference from a Distributed Transmission Network

Analysis of interference from a distributed transmission network to a single-transmitter station can be a relatively straightforward extension of the methods already in use for interference analyses between single transmitters. The signals from the several transmitters in the distributed transmission network must be combined in the analysis of interference to neighboring stations. To treat the distributed transmitters together, there must be a way of indicating in the FCC's database and in the software that performs the interference analysis calculations that the several transmitters of the distributed transmission network are to be considered as a group. This will require the addition of one field to the records of the distributed transmitters in the FCC's database (CDBS) and in the processing software. The field will contain an identifier to associate the members of a distributed transmission system with one another. (That additional field is believed to be the only administrative addition required in processing applications for distributed transmitters. The remainder of the changes all will be in the interference analysis software.)

There are two fundamental ways in which the handling together of the distributed transmitters in a network could be carried out. The first is the simplest and requires that the transmitters of the distributed transmission system simply be grouped together when comparing interference to a neighbor from the preexisting situation and from the proposed configuration. In this instance, the group of distributed transmitters would replace the FCC DTV Plan facilities when analyzing the change in interference to neighbors, but no other changes in the analysis algorithm would be made. The result is that the distributed transmitters would be permitted to mask one another, as is done with unrelated stations when considering their combined effect on a station under study. The effect of this treatment would be that the strongest signal from any of the distributed transmitters in the network would be determinative of whether interference was predicted at each grid point studied by the interference analysis software.

The second method of treating the transmitters from a distributed transmission network as a group is to aggregate the signal power levels from all the transmitters in the network and to use their combined power at each grid point as the interfering signal level in the analysis. This is only slightly more complicated than the first method in that the calculation of the received signal level for each of the individual transmitters in the network would be carried out in just the same way as done by current methods. Prior to determining at each grid point the D/U ratio from the distributed transmission network to the station under study, the received signal levels from the distributed transmitters in the network would be summed in an appropriate way. The received signal levels would be those determined using all the assumptions about the various planning factors, directional receiving antenna aiming, and the like that are already built into the interference analysis software. The value obtained then would be used for the undesired signal level in the determination of interference. Thus, one more step would be added to the process of determining whether interference was predicted at a given grid point, i.e., the summing of the received power from the distributed transmitters. The effect of this treatment would be that the aggregated received power from the entire distributed transmission network would be determinative of where interference was predicted by the interference analysis software.

Interference to a Distributed Transmission Network

In considering interference to a distributed transmission network from a single-transmitter station, the analysis needs to take into account the possibility that the signal received from the network at any grid point could come from any of the transmitters in the network. It also needs to recognize that there will be overlapping coverage of the multiple transmitters in the network and that double-counting of interference that could result must be avoided. To address these requirements, two modifications are needed in the way the analysis is set up, and then the standard algorithm in the software can be used for the remainder of the calculation.

The two modifications in setting up the analysis concern the way in which the analysis grid is established and the way in which the aiming direction of the receiving antenna is determined. To take into account the overlapping coverage of the multiple transmitters and to avoid the double counting of interference that would occur if interference to those transmitters were considered separately, a single, unified analysis grid would be established for the entire distributed transmission network. The grid would originate from the “main,” “primary,” or “reference” transmitter that would be indicated as the reference point for the network in the added field in the FCC’s database. The grid would be laid out from that starting point in the same way as for single transmitter analysis. The outer bounds of the grid to be analyzed would be derived from the union of the noise-limited contours of the several distributed transmitters in the network. In other words, the outer boundary of the analysis grid would be drawn around the farthest points of each distributed transmitter’s noise limited contour as seen from the reference point. Where there were multiple transmitters in between the reference point and the farthest point of coverage in any direction, only the contours of the transmitters reaching those farthest points would be included in circumscribing the outer boundary of the analysis grid.

Once the analysis grid was set up, it then would be necessary to determine the aiming direction for the receiving antenna assumed by the software to be at each grid point and to determine the received signal level from the network to be used for the “desired” value in calculating whether interference was predicted at each grid point. To decide the aiming direction for the receiving antenna at each grid point, it can be assumed that the transmitter producing the strongest field strength at each grid point is the one that will serve that grid point. Thus, normal calculations of field strength built into the existing software would be used to determine the signal delivered by each transmitter in the network to each grid point. The strongest of them at each grid point would be selected and used for the remainder of the calculations. The receiving antenna would be assumed aimed toward the transmitter delivering the strongest field strength to the receiver’s associated grid point. The received signal level from the transmitter selected at each grid point then would be used as the “desired” signal value in the calculation of D/U ratio and in the determination of the presence of interference there. The result would be that, after setting up the initial conditions for the desired signal at each grid point, the analysis of interference there would proceed in the manner already built into the software.

Interference between Distributed Transmission Networks

Treatment of interference between distributed transmission networks would combine the techniques previously described for analysis of interference from distributed transmission systems to single-transmitter stations and from single-transmitter stations to distributed transmission systems. The two modifications to the procedure would be concatenated in order to carry out the evaluation of interference. In the actual processing of the analysis, the order of application of the modifications likely would be reversed from the order in which they were discussed above. That is, the layout of the study grid for the "desired" distributed transmission network would be set up first. This would include selection of the distributed transmitter serving each grid point and the aiming of the corresponding receiving antenna toward the selected transmitter. Then the interference at each grid point would be determined in the same way as when analyzing interference from distributed transmitters to a single-transmitter desired station. Thus the methods described above for that case would be applied to the conditions established for each grid point.

As has been shown, the analysis of interference involving distributed transmission networks would involve a total of three modifications to the analysis software in use by the Commission and the industry. One of two choices of modification would be applied to the case of interference from distributed transmitters to single-transmitter stations. Two modifications would be applied to the case of interference from single-transmitter stations to distributed transmission networks. All three modifications would be used in analysis of interference between distributed transmission networks. It is anticipated that the software modifications required would not be unduly complex or difficult to achieve. It would be required to add one field to the records of distributed transmitters in the FCC's CDBS database to enable the modified analysis methods.

Conclusions

As demonstrated above, the technology of distributed transmission can be an extremely valuable tool for many broadcasters in providing expanded DTV service to the public. With relatively few changes to its Rules, the Commission can and should develop a regime that enables routine licensing of distributed transmission systems. Because distributed transmission systems will help accelerate the DTV transition in a spectrally efficient manner, the Merrill Weiss Group LLC submits that the rule changes supported herein are decidedly in the public interest.

Respectfully submitted,

Merrill Weiss Group LLC

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