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In Re

The Impact of Advanced
Television Technologies on
Local Television Broadcasting

CM-5811

PETITION FOR NOTICE OF INQUIRY

The emergence of high definition television (HDTV) places local television service at an historic crossroads. The Commission's spectrum allocation policies will largely determine what happens at that crossroads. A failure to adjust the Commission's current allocations scheme could preclude efficient marketplace guidance at this critical juncture and, in doing so, vitiate public policy values that are mandated by the Communications Act and embodied in our present system of local television stations.

This Petition urges the Commission to initiate an inquiry into the issues arising from the introduction of HDTV and other advanced television technologies and the possible impact of such new technologies on the universal availability of local broadcast service and on the viability of the local broadcast system. The Petition sets forth specific areas of inquiry which will provide the Commission

with an adequate basis for making the spectrum allocations determinations which are needed.

Should the Commission decline to initiate such an inquiry, it may have made one of the most important spectrum allocations decisions in its history by default. As detailed in the Petition, there is strong reason to fear that unless local broadcast stations receive additional spectrum, they will become, at best, a second-class service. Thus, even if the Commission does nothing in response to this Petition, it will have made a decision -- one that may profoundly alter the structure of an industry and affect every one of the more than 98 percent of the American people who rely on local television service.

The path proposed in this Petition is one the Commission has trod many times before, starting with the initial question of how much spectrum to allocate to local television.^{1/} See Color Television Issues (First Report of the Commission), 41 F.C.C. 1, 2-10 (1950). More recently, the Commission has engaged in similar inquiries with respect to the spectrum needs of the direct broadcast satellite, Direct

^{1/} Indeed, the Commission has no more central role under the Communications Act than to determine how to allocate spectrum. This Petition merely asks the Commission to make that decision with respect to HDTV on the basis of an informed record.

Broadcast and Satellites, 90 F.C.C. 2d 676 (June 23, 1982), and land mobile industries, Notice of Inquiry, PR Docket 82-10 (January 13, 1982). The undersigned are confident that this Commission will give careful study to the many factors that will affect the ability of local television stations to participate in high quality television.

We believe that the areas to be explored include the following:

- (1) the features, capabilities and developmental status of advanced television production, transmission and reception systems either now under development or whose development is foreseen, including improvements in the current NTSC system, enhanced 525-line systems and HDTV systems;
- (2) the extent to which each of these new technologies is compatible with
 - (a) existing NTSC receivers, and,
 - (b) current local broadcast channels;
- (3) the extent to which each of these new technologies can be transmitted by home video delivery vehicles competitive with local broadcast stations, including cable, VCRs, videodiscs, DBS, and MMDS/ITFS;
- (4) the means by which the various improved television technologies will enter the home video marketplace, the timetables under which they will do so, and the effect they will have on the home video market;
- (5) the perceived public interest implications of these developments, including the effect on the universal reach, competitive posture and long-term viability of the local free broadcasting system; and,

- (6) the options the Commission might consider to provide local broadcast stations the opportunity to compete in the home video markets of the future, including appropriate spectrum-allocation and interference-protection policies.

I. INTRODUCTION AND SUMMARY

The quality of the video programming now delivered to homes in the United States derives almost entirely from transmission specifications developed for the local television broadcast industry over 45 years ago. These transmission standards, developed and later refined by the National Television Systems Committee (NTSC), have proven to be remarkably flexible and durable, permitting dramatic advancements in picture quality without fundamental systemic change.

Thus the NTSC system has been able to accommodate such radical transitions as the improvements from black-and-white to color pictures and from monophonic to stereophonic sound without rendering millions of existing television receivers unusable. Just as striking, the improved quality signals can still be transmitted in the same 6 MHz-wide television channels agreed upon by the Radio Manufacturers Association in 1936 and used for WNBT-TV's first commercial over-the-air transmission in 1941.

Preserving access to existing receivers and using existing broadcast channels have ensured the continuing universal availability of free local broadcast service to the

American people. They have also fostered a period of regulatory stability which, in turn, has facilitated the entrepreneurship and responsiveness to consumer needs that have characterized this country's local broadcast system.

The flexibility and potential of the NTSC system may now be exhausted. It is probable that the next quantum leap in video image quality will not be compatible with existing receivers and existing broadcast channels. The result could be the loss of local broadcast service for millions of consumers and/or a crippling of the local broadcast industry.

The catalytic technological development is the imminent appearance in the marketplace of high definition television (HDTV). HDTV is a constellation of major quality advances over current NTSC pictures. The cumulative magnitude of these advancements is roughly comparable to the differences between color and black-and-white images and between 35 mm and 16 mm film.

Japanese-developed and manufactured home HDTV receivers and videodiscs and cassettes should be on the consumer market in both Japan and the United States within the next three years. Japanese HDTV production equipment is now being used by business and commercial users and cinematic production houses all over the world. Satellite broadcasting of HDTV will begin in Japan within the same time frame.

The Japanese HDTV system will not, however, be carried by local broadcasters in this country (or in Japan): local broadcasters cannot transmit the required wideband HDTV signal in the narrow 6 MHz channels they have been allocated by the Commission. While considerable efforts undoubtedly will be exerted to develop high-quality 6 MHz systems, it may be that local broadcasters will never be able to carry a picture of quality comparable to that of the Japanese HDTV picture within their current 6 MHz channels. Moreover, even if broadcasters could carry HDTV signals on their current channels, it would only be by means of an entirely new transmission standard, rendering their signals unreceivable on the existing 130 million NTSC receivers.

No other home video delivery service faces either the transmission bandwidth or receiver-incompatibility hurdles confronting local broadcasters. Cable, MMDS/ITFS, videodiscs and cassettes, and satellite delivery systems all have ample radio spectrum to deliver an HDTV picture. And all of them can initiate HDTV service without abandoning (or providing converters to) households with NTSC-only receivers. Cable, for example, can "simulcast" the same programming in NTSC and HDTV on two different channels.

The result is that local broadcasters could be shut out of the HDTV marketplace. They may be relegated to the provision of a second-class service, much like AM radio

stations competing with superior FM signals, only more so. Or, if some as-yet-unforeseen breakthrough allows them to convert to HDTV using existing channels, it may be at the cost of depriving millions of viewers of their service or come at such a late stage that local broadcasters will already have been permanently injured.

The Commission clearly has the capability and opportunity to avert these developments and ensure that free, local programming has the option of remaining a universally available home video service. The undersigned believe that the public interest values reflected in Section 307(b) of the Communications Act require it to do so.

In any event, the potential impact of the HDTV transition on the local broadcast system of this country has sufficiently serious spectrum allocation implications to warrant an immediate and thorough Commission investigation along the lines requested in this Petition.

II. ASSESSING THE PROBLEM: THE TRANSITION TO AN ADVANCED TELEVISION SYSTEM

The objective of the proposed proceeding is to enable the Commission to make an informed determination as to what regulatory measures, if any, are necessary to ensure that the free, universal service provided by local broadcasters has an opportunity to compete in the video marketplace of the future. The first step in this process is to

identify and assess the magnitude of the problem. This will require examining the foreseeable advancements in television technology and determining the extent to which they are compatible with this country's local broadcast system and with competitive systems. As part of this inquiry, the Commission should assess the likelihood that local broadcasters will be excluded from these advancements and, if so, whether this exclusion will impact adversely upon the public interest objectives now fulfilled by the local broadcast system.

A. Limitations of the Current NTSC System

Home video delivery systems, of which local television broadcasting is one, can be divided into three basic elements, corresponding to the progress of the video product from the studio to the home: production, transmission and reception. In the United States, the basic engineering characteristics of all three of these components were essentially fixed by the NTSC in 1940.

At the time of the NTSC, local broadcasting was, of course, the only home video transmission system available. Since then, numerous alternative transmission systems have entered the home video market. However, because of the importance of local broadcasting in the home video market, the NTSC standards have governed not only over-the-air transmission but video production and display as well.

As dictated by the NTSC, the basic features of the U.S. broadcasting system included a black-and-white picture composed of 525 horizontal lines of resolution, with interlaced scanning at 60 fields per second, an aspect (width-to-height) ratio of 4:3, and monophonic sound. This standard reflected the technological limits of the late 1930's. Since then, there have been two major improvements to the NTSC signal: the introduction of color in 1953, and the introduction of stereo sound in 1985. In addition, a host of lesser adjustments have improved picture clarity and detail and expanded the viewable portions of the recorded image.

Not surprisingly, the 45-year-old NTSC system, even as modified, no longer represents the limits of technological possibility. Improved television systems are now under development, or are actually being marketed, that improve greatly upon one or more of the following characteristics.

First, and most important, is resolution, both horizontal and vertical. Particularly on large-screen projection sets, the individual lines in the NTSC signal, the "raster," are clearly noticeable. Increasing the number of lines makes them virtually invisible to the viewer, while simultaneously making it possible to show finer detail.

Next are picture sharpness and color fidelity, both of which are severely limited in the NTSC receiver as a

result of the engineering compromises that were required to make a compatible transition from black-and-white to color. To add color without making conventional monochrome sets obsolete,^{2/} the NTSC system conveys the brightness (luminance) and color (chrominance) information in interwoven, overlapping spectrum segments. Because they are interwoven, the two signals may interfere with each other, degrading the picture with "cross-color artifacts" and "cross-luminance artifacts." To circumvent these effects, receivers often are designed to process only a portion of each signal, thereby minimizing the undesirable "artifacts." At the same time, the technique limits the amount of receivable bandwidth, causing blurriness and a lack of color fidelity.

Third, the NTSC "aspect ratio," the ratio of picture width to height, of 4:3 reflects the dimensions of the cinema screens of the 1930's. Psychophysical research has conclusively demonstrated that viewers obtain a greater sensation of reality and involvement from a display widened to correspond more closely to the dimensions of the human

^{2/} By contrast, European broadcasting systems made the transition to color by devising transmission systems which were incompatible with the existing monochrome service. The "transition" to color was made by simulcasting the same programming on two different channels, one monochrome and one color.

visual field. Thus, modern cinema screens have aspect ratios of 5:3 or even 2:1.

Fourth, the NTSC sound signal is also subjected to significant bandwidth and modulation technique limitations. These limitations, while perhaps not noticeable on the four-inch or six-inch speaker in a conventional television set, are now readily apparent to a new generation of audiophiles who listen to the television soundtrack through their home stereo equipment. The capability now exists to transmit a digitalized sound carrier with quality comparable to that achieved on compact discs.

B. Advanced Television Technologies

There exists, then, the potential for significantly improving the technical quality of home video. A wide variety of proposals have been or are being developed to take advantage of some or all of this potential. Pursuant to a taxonomy developed by the Advanced Television Systems Committee, these proposed advancements include 1) improved NTSC systems, 2) enhanced 525-line systems, and 3) HDTV systems.^{3/}

A number of the advancements in the first two categories are described in Appendix A. The Commission will

^{3/} A noncomprehensive bibliography of advanced television system literature is contained in Appendix B.

want to solicit information as to the principal features of each of these systems (including their compatibility with each of the current modes of home video delivery), the state of development of each such system, and the extent to which some or all of these advancements will ameliorate the technological handicap now facing NTSC-based systems.^{4/}

The Commission will want to solicit comment specifically on the most far-reaching development, HDTV. HDTV systems are those video technologies that attempt to reach the maximum degree of quality perceivable by the human eye and ear. The principal, though not the only, proponent and developer of such systems has been the Japan Broadcast Corporation (NHK).^{5/} NHK's system has been under development for 15 years at the cost of hundreds of millions of dollars.

The NHK HDTV system improves each of the previously identified shortcomings of the NTSC system:

^{4/} Among the entities pursuing improved NTSC is the Center for Advanced Television Studies ("CATS"), which several of the undersigned support.

^{5/} NHK is a corporation owned by the government of Japan and funded through an annual television receiver tax. NHK currently provides two channels of programming, distributed by a nationwide translator system. NHK's video electronics research and development laboratory, the largest in the world, has spent the last 15 years developing HDTV.

Other developers of HDTV include North American Philips and the New York Institute of Technology. See sections II.C.2 and II.D.

1) Horizontal and vertical resolution are more than doubled, reducing the visibility of the raster, and greatly improving picture detail;

2) Luminance and chrominance bandwidths are increased substantially and the subcarriers are separated in time, greatly improving clarity and color fidelity and eliminating cross-color and cross-luminance artifacts;

3) The aspect ratio is increased to 16:9, significantly expanding the field of vision and improving the viewer's sensation of reality;

4) The sound carrier is digitalized to provide compact-disc quality sound.

The cumulative effect of these improvements is to create a video system with quality comparable to that of 35 mm film, a significant advancement over the 16 mm film quality of the current NTSC system.

C. Compatibility with NTSC Receivers and Local Broadcast Channels

1. The Incompatibility of the NHK System

The NHK studio production system requires over 30 MHz of spectrum for transmission in full bandwidth form. To permit the transmission of its HDTV system over narrower satellite channels, NHK has developed a special bandwidth compression format known as MUSE (Multiple Sub-Nyquist

Sampling Encoding), which compresses the initial 30 MHz production signal to 8.1 MHz.^{6/}

The MUSE system was demonstrated at the Commission by MST and NAB in Washington last month using UHF (Channels 58 and 59) and 13 GHz frequencies. At that demonstration, NHK engineers reiterated their long-held position that no further reductions in transmission bandwidth are possible without unacceptable reductions in picture quality. Indeed, some believe that even the MUSE system suffers from excessive bandwidth compression.

Thus, the NHK system is compatible with neither local broadcast channels, which are only 6 MHz wide, nor with existing NTSC receivers, though it is possible to use an add-on converter to display a reduced quality MUSE signal on existing NTSC sets. Of the nonbroadcast home delivery media, cable, fixed and direct broadcast satellites, and videocassettes and discs all potentially have the necessary

^{6/} To accomplish this compression, the MUSE system employs sophisticated frame stores and motion sensors to take advantage of the fact that the human eye is less able to distinguish detail in moving than in still objects. The MUSE system fools the eye by displaying the non-moving parts of the picture at full resolution, while showing the rapidly changing parts of the picture at one-fourth the maximum resolution. As a result, transmission bandwidths can be reduced with little appreciable diminution in quality.

bandwidth to carry MUSE or similar transmissions.^{7/} Because of its conviction that 6 MHz-wide channels are simply too narrow to ever accommodate a true HDTV quality image, NHK has made no effort to try to develop an HDTV transmission system which could be transmitted in 6 MHz-wide channels.

2. The Compatibility of
HDTV Alternatives

There are a number of other HDTV over-the-air transmission systems under development. At least one such system, that of Dr. William Glenn at the New York Institute of Technology (NYIT), would be compatible with existing NTSC receivers. Under NYIT's system, an NTSC signal would be sent over the existing broadcast channel and could be received by the current sets. A second channel, approximately 3 MHz wide, would send the supplementary information necessary to complete the HDTV picture. A microprocessor in HDTV receivers would combine the two channels for an HDTV display. North American Philips is reportedly developing a similar system which would employ a second 6 MHz channel.

^{7/} MMDS licensees control multiple 6 MHz-wide channels, which could be used to carry HDTV systems which employs dual non-contiguous transmissions. MMDS channels licensed to a single licensee are not contiguous and thus cannot carry a contiguous 8 MHz signal. However, MMDS channels are adjacent to the channels of both other MMDS licensees and ITFS licensees, who are allowed to lease a substantial portion of their channels for commercial purposes.

The NYIT and Philips systems could not display HDTV pictures using local broadcasters' 6 MHz wide channels. The undersigned are aware of no proposed HDTV systems which would be compatible with current, unsupplemented broadcast channels.

D. The Developmental Status of HDTV

Japan, in concert with the United States, staged a multi-year campaign to have the NHK HDTV studio system adopted as a de jure world production standard by the CCIR. Despite the fact that the CCIR deferred this proposal until at least 1989, the NHK HDTV system seems likely to become the dominant HDTV system for the foreseeable future. At least five different Japanese equipment manufacturers are already producing equipment geared to this standard; one of these, Sony, is already marketing to business and commercial users and video producers in this country and abroad a complete production system including cameras, videotape recorders, editing machines and receivers.^{8/}

^{8/} The motion picture industry appears a likely initial market because HDTV equipment holds the prospect of substantial cost reductions, particularly for post-production special effects. At least one joint venture, 1125 Productions, is already working to complete three feature film deals in Hollywood in 1987. The Italian public service broadcast company, RAI, will release this spring a \$10 million full-length feature HDTV production. The Canadian Broadcasting Corporation has also produced a \$10 million, 13-hour mini-series in the HDTV format.

Moreover, as evidenced by the January demonstration in Washington, D.C., NHK has perfected its MUSE system for over-the-air transmission of HDTV programming. By 1990, NHK plans to begin transmitting two channels of MUSE HDTV signals to every home in Japan over its BS-3 direct broadcast satellite. A third MUSE channel on that satellite will carry HDTV programming from a consortium of local Japanese commercial broadcasters.

In keeping with the initiation of satellite broadcasting, NHK and its affiliated manufacturers intend to have home receivers ready for mass marketing by 1990. Home videocassette players and videocassettes will be available in the same time frame. NHK anticipates that the receivers developed for home use will be capable of receiving and displaying both HDTV and NTSC pictures.

Because of its wide bandwidth, of course, the MUSE system will not be available for transmission by terrestrial broadcasters, either in Japan or the United States. The other HDTV transmission systems known to be under development, those which are compatible with NTSC receivers, appear to be considerably further away from the consumer market. The NYIT and North American Philips systems have been demonstrated in prototype and MST and NAB hope to demonstrate these systems in their series of HDTV experiments.

A central objective of the proposed inquiry must be to acquire further information about the state of development of all of these systems and the manner, speed and extent to which they are likely to penetrate the home video market in this country.

III. THE IMPLICATIONS OF HDTV FOR LOCAL, UNIVERSAL AND FREE TELEVISION SERVICE

The Commission should also seek comment on the extent to which the development and introduction of advanced television systems, particularly HDTV, into the home video marketplace will affect the public interest objectives served by the country's universally accessible local broadcast system.

This inquiry will revolve around the concept of "compatibility." Compatibility, as used here, is important in two respects: 1) compatibility of advanced television systems with existing 6 MHz-wide broadcast channels; and 2) compatibility with existing NTSC receivers.

It has now become clear that a major effort will be mounted over the next decade to supplant the existing NTSC home video standard with the NHK HDTV system. It is also clear that the NHK HDTV system can and will be distributed to homes by means of cable, videocassettes and discs, and, quite possibly, by DBS and MMDS/ITFS.

Because of the first type of incompatibility, channel-bandwidth limitations, local broadcasters will be the only major home video medium which cannot transmit the NHK HDTV system. Proponents of the NHK system assert that it is a qualitative improvement over NTSC of the magnitude of color over black-and-white and greater even than the difference between AM and FM radio. If viewers agree with this assessment, then the survival of local broadcasters' service will depend on finding an alternative means of providing a comparable quality of signal.

Many informed observers believe that no system of comparable quality can be developed within the constraints of broadcasters' 6 MHz-wide channels. And, even if such a system could be developed, it appears to be many years off. Given the potential rapidity and degree of market penetration by the NHK system, the local broadcast system could be substantially and permanently impaired before a 6 MHz-wide HDTV alternative could be developed.

Moreover, there is even less likelihood that such a system would be compatible with existing NTSC receivers. To get an HDTV signal into a 6 MHz channel will almost certainly require a transmission method which differs radically from NTSC and which will not be receivable on NTSC sets.

Add-on converters may make it possible for NTSC sets to convert HDTV signals to an NTSC display. For many



such receivers, however, particularly low-cost receivers, it may not be technically possible or cost-effective to install converters. And even if the cost of such converters and their installation is modest, which is unlikely, the total cost merely to maintain the existing NTSC service would be several billion dollars.

By comparison, broadcasters' competitors will be able to reach all NTSC and HDTV receivers without the necessity for tampering with every NTSC set. Videodiscs and cassettes will come in both formats, just as audio recordings come in both LP's and compact discs. Cable, satellite and MMDS operations have ample spectrum to "simulcast" NTSC and HDTV signals over two separate channels. The conversion to HDTV no doubt will be facilitated by the fact that HDTV receivers will be "downward compatible," i.e., able to display both HDTV and NTSC signals.

As a result of this disparity, non-broadcast services would be able to convert much more rapidly to HDTV even if broadcast-channel-compatible HDTV were ever developed. Indeed, it is entirely possible that local broadcasters, which, as an advertiser-supported service, are uniquely dependent upon universal coverage, might never make the transition.

These scenarios are not foregone conclusions. As described in Appendix A, there are a number of impending

improvements in the NTSC system which, whether or not they are to duplicate the quality of the HDTV image, may nonetheless reduce HDTV's relative superiority. The Commission should, of course, carefully examine the question whether these fully compatible improvements will sufficiently bolster the competitiveness of the local broadcast system so that it will continue to fulfill the public interest needs it now serves.

In addition, there may be other ways, such as the NYIT and Philips HDTV systems, to upgrade the local broadcast system without discontinuing service to all existing receivers (or requiring that converters be attached to every existing set). However, in all known instances, the implementation of these set-compatible technologies will require the use of spectrum in addition to the current 6 MHz channels and thus will require spectrum adjustments by the Commission.

In any event, the Commission should expressly solicit comment on the likelihood that, in the absence of Commission action, the transition to advanced television technologies will damage or destroy the local broadcast system and whether it will result in a temporary or permanent deprivation of television service for a substantial portion of the American people.

IV. REGULATORY OPTIONS

Pursuing the foregoing areas of inquiry should give the Commission an adequate basis for determining whether there is a significant likelihood that the transition to a materially higher quality home video service will have an adverse impact upon this country's local broadcast system. The Commission will then have to determine the appropriate regulatory response.

The undersigned believe there is a clear and present danger to local broadcast service, and that this inquiry will show that to be the case. But, at the least, the information recited in this petition certainly justifies the modest step of seeking comment on HDTV and other advanced technologies and on possible regulatory responses.

A. Regulatory Inaction

One possibility is to do nothing, to let the Commission's present allocations structure and the existing home video marketplace be the sole determinant of which home video delivery systems, including local broadcasting, will survive the transition to HDTV. Central to this inquiry will be the question whether the marketplace will function properly if left alone.

Two distortions in the functioning of the home video delivery market are likely to result in a significant misallocation of resources contrary to the public interest.

First and foremost is the fact that local broadcasting is dependent upon a resource, radio spectrum, which is allocated and severely restricted by the federal government. Thus local broadcasters are restricted to certain portions of the usable spectrum, the VHF and UHF bands, and each broadcaster is restricted to a maximum of 6 MHz of contiguous spectrum in each market. Neither cable nor video-cassettes/discs have any such restriction on transmission bandwidth. While two other home video delivery services, DBS and MMDS/ITFS, are also dependent upon government spectrum allocations, both have received generous spectrum allotments in a form readily adaptable to wideband HDTV transmissions. For local broadcasters alone, then, the transition to HDTV is a question not simply of capital investment but of government allocations policy.^{9/}

Second, the principal impelling force for the transition to HDTV is not a development generated by a free market but the output of a research and development

^{9/} Put another way, the home video delivery market is not one which has been structured free of government intervention. Since the Radio Act of 1927, the broadcast media have developed within the allocations framework mandated by a federal agency. We do not criticize that fact; the framework was essential to the initiation and growth of the local broadcast system. But it should not be surprising that the allocation framework would need adjustment to accommodate new technologies.

laboratory funded entirely by the government of a country with very different policy priorities and needs. HDTV was developed with the express intent of distributing HDTV programming exclusively by satellite and videocassettes and discs. It was never envisioned that local broadcasters would have a role in the provision of HDTV in Japan, except perhaps as the programmers of one of the nationwide satellite HDTV channels.

As a result, the dislocations and policy implications of the transition to HDTV in this country have not been thought through. Certainly the adjustments to the American home delivery market which will be required to implement HDTV will be quite different and much more radical than those faced by the Japanese.

The Commission should also inquire whether there are public policies which will be affected by the relegation of local broadcasting to an ancillary status. These public interest concerns include but also go beyond the issue of efficient allocation of resources. In particular, the Commission should inquire as to the impact of its current allocation policies relating to HDTV as they affect (i) the local nature of existing services (Section 307(b) of the Act); (ii) the public interest component of local broadcast service, including the noncommercial broadcast system; (iii) the advertiser-supported ("free") character of local commercial