channels, but rather, that ATV could develop as a separate service.[91] This option would permit broadcasters either to (1) simulcast programming in NTSC and ATV; (2) broadcast in ATV only and abandon NTSC or (3) continue using only NTSC.

2. Studies Related to Spectrum Availability for ATV

a. Advisory Committee Spectrum Study

54. The Planning Subcommittee of the Advisory Committee established the Spectrum Utilization and Alternatives Working Party (Working Party 3) to study the availability of spectrum to support various alternative technical systems for terrestrial ATV service. Its report and conclusions were limited by the short amount of time available as well as the fact that the exact characteristics of the proponent ATV systems are not known. This Working Party is continuing to study spectrum alternatives.

55. Since the spectrum requirements for many of the proposed systems, their interference characteristics, and the interference performance of ATV receivers were not known, the Working Party developed a set of assumptions regarding these criteria. Using two similar computer data bases supplied by the FCC and the NTIA containing information on existing television assignments, the Working Party estimated the number of stations that could be accommodated with additional spectrum under various assumed conditions using the existing VHF and UHF allocations. In its analyses only co-channel and adjacent channel interference were considered. Other UHF taboos were disregarded.

56. The Working Party drew two broad conclusions from its study. (1) "[T]he greatest likelihood of finding additional spectrum for each station to use in conjunction with their existing channels on either a compatible or simulcast basis occurs when the additional spectrum is not necessarily contiguous"; and (2), "there are combinations of cochannel and adjacent channel interference performance/protection which might allow the utilization of extra spectrum for all existing stations and allotments to provide [ATV service]."[92]

57. The Working Party concluded that in order to have a reasonable chance of accommodating most present stations, in the worst case the ATV supplemental channel would have to be capable of tolerating a 6 dB D/U

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91 CBS Comments at 31.

92 Advisory Committee, Report of the Spectrum Utilization and Alternatives Working Party (Working Party 3) of the Planning Subcommittee at 1 (April 17, 1988).

ratio.[93] If the system could not tolerate these conditions for the supplemental channel, either fewer than all stations could be accommodated, or ATV service areas would have to be smaller then current service areas. The Working Party also concluded that assignment of supplemental spectrum would be more difficult in urban areas than in rural areas.

58. A report on ATV use of channels affected by the UHF taboos was submitted to Working Party 3 by Donald M. Jansky and Robert A. O'Connor. This report argues that the taboos are not necessarily a barrier to the introduction of ATV systems because these systems can be designed to use taboo spectrum without causing unacceptable interference to NTSC receivers, and ATV receivers can be designed to eliminate any interference that may be caused by NTSC transmissions. Jansky and O'Connor note the technical advantages of co-location, stating that co-location of transmitters provides better protection for both IF beat and intermodulation interference than the currently required 20 mile separation. Also, they state that an ATV augmentation signal would have none of the characteristics that led to adoption of the taboos. Finally, using data submitted in Zenith's comments, they predict that ATV augmentation signal power levels will be low enough not to cause interference to UHF NTSC broadcasting.[94]

59. With regard to its study of spectrum between 1 and 13 Ghz, the Working Party concluded that although all of this spectrum is allocated and being used, it may be feasible to accommodate an ATV system on a shared basis in some part of this range. It stated that further consideration will await the results of propagation tests being conducted by ATSC to determine the feasibility of possibly using spectrum in this microwave range for terrestrial ATV broadcasting.

b. OET Studies of Spectrum and Receivers

60. As discussed in the NOI, the availability of spectrum is an essential factor in considering the options for implementing ATV service. The Commission's Office of Engineering and Technology (OET) has performed two studies that analyze the availability of spectrum for ATV service. The first study examined the possibility of providing existing television stations with additional spectrum for ATV within the existing VHF and UHF allocation. Additional spectrum considered by this study would be made available principally by eliminating the UHF assignment restrictions

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93 Id. at 18.

94 See Jansky and O'Connor Impact of the UHF-Taboos on Availability of Spectrum for Advanced Television Systems, attached to Report of Working Party 3 of the Advisory Committee's Planning Subcommittee.

generally known as the "UHF taboos."[95] The second study examined receiver performance to determine the potential for interference to present receivers if the taboo channels were used for ATV augmentation. Reports describing each of these studies have been placed in the record.[96] We invite comment on these studies and the implications of their results for possible allotment of additional spectrum for ATV purposes.

61. Spectrum Availability Study. The spectrum availability study was conducted in two phases. Phase 1 examined the results of providing an additional 3 or 6 MHz contiguous to existing assignments and is germane to systems that require a contiguous channel 9 or 12 MHz wide. Phase 2 examined the possibility of assigning an additional 3 or 6 MHz that is not necessarily contiguous to existing assignments, and applies to those systems that use supplements of 3 or 6 MHz that need not be contiguous to the existing channels with which they would be associated. Phase 2 also applies to systems that are intended to be introduced through simulcasting on a 6 MHz channel. OET also is working on additional research that will examine the utility of minor modifications to the allotment tables to obtain additional spectrum capacity. Results of this third phase of the study will be released when the work is completed.

62. In large measure the availability of spectrum depends on the locations of existing stations and restrictions on the minimum distance between stations that are necessary to prevent interference.[97] Additional spectrum assignments for ATV systems also would be subject to minimum distance separation requirements, although the distance might differ from that in our existing rules due to factors such as different transmission techniques or service areas of different sizes.

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95 An explanation of the UHF taboos is provided, infra, in the context of the OET receiver study.

96 See Interim Report: Estimate of Availability of Spectrum for Advanced Television (ATV) in the Existing Terrestrial Broadcast Bands FCC/OET TM 88-1, and Analyses of UHF TV Receiver Interference Immunities Considering Advanced Television, FCC/OET TM 88-2.

97 The required distance between TV assignments generally correlates with the ratio of desired-to-undesired signal strengths (D/U ratio) if the transmission power and antenna height and gain are kept constant. The greater the separation, the greater the D/U ratio. The minimum required D/U ratio depends upon a number of factors, including the desired picture quality, the interference rejection characteristics of the receiver, and the antenna characteristics.

63. The spectrum availability study analyzed the percentage of existing authorized stations, applicants, and permittees that could be provided additional spectrum for minimum separation distances ranging from 190 miles to 100 miles. The distance of 190 miles was selected for the upper limit because it roughly approximates the current NTSC cochannel minimum separation distance.[98] With stations at a minimum separation distance of 100 miles, ATV receivers would be required to operate with much lower D/U signal margins than existing NTSC receivers. Currently, existing NTSC broadcast service extends to at least 40 miles without interference from cochannel stations with present minimum spacing requirements. To provide about the same coverage for ATV stations separated by only 100 miles, receivers would have to be able to operate with a D/U margin of only 6-10 dB rather than the 28-45 dB[99] margin typical of NTSC receivers. This condition may be very difficult for ATV technology to achieve, and shortcomings would result in reduced service areas or fewer than all stations being authorized to broadcast ATV service. Therefore, it was deemed impracticable to study separation distances less than 100 miles. The study also used the current standard of 60 miles for adjacent channel separation distance.

64. For purposes of this description of the studies, the term "existing stations" means: (1) licensed stations; (2) prospective stations with valid construction permits; and (3) pending applications that have been accepted for filing as of June 1988.[100] A computer program based on geographic spacing methods for station assignments was used to assist with the analysis. Heuristic methods that tend to maximize the number of assignments by making the most highly constrained assignments first were

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98 See 47 C.F.R. § 73.610 (1987) for the current mileage restrictions between cochannel stations. The cochannel mileage restrictions vary by zone and are different for VHF and UHF channels, ranging from 248.6 kilometers (154.5 miles) to 353.2 kilometers (219.5 miles).

99 Use of precision offset carriers permits stations to operate at a 28 dB D/U ratio, whereas otherwise 45 dB D/U is necessary to obtain comparable reception quality.

100 There are 1760 stations in this data base, of which 706 are VHF and 1054 are UHF. Protection also is provided for existing land mobile operations on channels 14 through 20 in eleven major urban areas. Existing Canadian and Mexican stations are treated as requiring the same protection as U.S. stations but not requiring additional spectrum for ATV purposes. Low power television (LPTV) and translator stations are not included base due to their secondary status, therefore it is possible that some authorized LPTV stations may conflict with certain potential ATV assignments developed in our studies.

applied. For any given station, locally unused channels were treated as candidate spectrum for ATV. The distances to stations that would be cochannel to the candidate ATV spectrum were calculated. Candidate ATV spectrum with cochannel and adjacent channel separations exceeding specified minimum separation distances were identified as potentially available.

65. The study design incorporated several underlying assumptions and limitations. Only co-channel and adjacent channel interference were considered because these were assumed to be the dominant factors limiting additional spectrum use. Assignment taboos that we presently employ to compensate for the performance of existing receivers were assumed not applicable in this analysis. We believe this assumption is reasonable with regard to interference to ATV transmissions because it seems likely that, given present technology, ATV receivers immune to taboo-type interference can be designed and manufactured inexpensively. On the other hand, the degree to which the UHF taboos may be relaxed to accommodate ATV transmissions while NTSC is being used is unclear. This is discussed in the OET Receiver Study, below.

66. The spectrum availability study also did not consider the effect of additional channel assignments for ATV in Canada and Mexico. The availability of spectrum in the United States would be reduced if, as seems possible, Canada and Mexico also were to implement ATV in the current television broadcast spectrum.[101] While the immediate impact would be to stations along the borders, there may be an effect on ATV assignments in other areas. Also, there is an almost limitless combination of ATV spectrum assignments possible and the study only sought to derive general solutions for the assignment of additional spectrum. While the assignments are optimized to a degree, the computer-simulated solutions do not necessarily represent the most efficient assignment of additional spectrum. Further study is required before specific spectrum could be proposed for assignment to stations.

67. The results of the spectrum availability studies are shown in Tables 1 and 2 below. Table 1 summarizes the degree to which stations in the data base could be accommodated nationwide with additional spectrum for ATV in the existing VHF and UHF television bands. The spacings are measured from a hypothetical ATV transmitter to the nearest NTSC transmitter on the same channel. The 100 mile separation distance would accommodate all existing stations operating with ATV using 3 additional MHz. However, this distance could result in ATV service areas much smaller than NTSC service areas. It also assumes that ATV receivers can operate with significantly lower D/U ratios, as discussed above, a condition that may be

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101 See §§ 103-105, addressed to the treaties that govern our TV assignments in border areas.

difficult to achieve technically. In contrast, only 77 percent of existing stations can be accommodated if 190 mile separation is required. Because the major markets generally have the highest concentration of stations, the greatest problems in accommodating demand for additional spectrum for ATV will occur in these markets; and in these areas the percentage of stations that could be allotted additional spectrum may be significantly less than for the nation as a whole.

68. Table 2 illustrates the problem of providing additional spectrum for ATV in the major markets. The results presented indicate that the percentage of stations that could be allotted additional spectrum in several major markets may be significantly less than for the nation as a whole. While it may be possible to improve the percentage of ATV accommodation in specific markets by using criteria that prioritize assignments in those markets, under any criteria the most difficult problems in accommodating demand for additional ATV spectrum will occur in the major markets.

Table 1: Nationwide ATV Spectrum Availability

Based upon the OET study, this table indicates the percentage of existing stations[102] that could be allotted additional spectrum for minimum co-channel separations of 190 and 100 miles. Also, only adjacent and co-channel restrictions were considered. UHF taboo restrictions were not considered.

Amount of Additional Spectrum (MHz)	Minimum Co-Channel Separation 100 miles	190 miles	Conditions
3	77	22	ATV spectrum contiguous to station's existing channel.
6	63	17	
3	94	50	ATV spectrum in same frequency band, i.e., VHF with VHF, UHF with UHF, not necessarily contiguous
6	84	38	
3	100	77	ATV spectrum anywhere in existing VHF/UHF broadcast bands, not necessarily contiguous
6	98	61	

Note: These results approximate an optimized solution through the use of heuristic techniques that were developed to attempt to accommodate the largest number of stations nationwide.

102 See ¶ 64, supra, for the definition of "existing stations".

Table 2: ATV Spectrum Availability in Major Markets

This table illustrates the percentage of existing stations in the top ten markets that could be allotted additional spectrum for ATV use. Results are based on adjacent and co-channel restrictions only. UHF taboos were not considered. The analysis assumes that VHF stations would be assigned supplemental spectrum only in the VHF band and that UHF stations would be assigned supplemental spectrum only in the UHF band.

City	Present No. Stations	Number of Stations Accommodated 6 MHz 100 miles	6 MHz 190 miles	3 MHz 100 miles	3 MHz 190 miles
New York	12	5	0	6	1
Los Angeles	15	9	5	12	5
Chicago	13	9	2	10	2
Philadelphia	10	5	0	6	1
San Francisco	13	8	8	9	8
Boston	10	4	0	7	3
Detroit	7	3	0	4	1
Dallas/Ft. Worth	15	11	9	14	9
Washington, D.C.	10	6	0	8	3
Houston	11	9	8	11	8
Nationwide	1760	1480 84%	673 38%	1655 94%	881 50%

Note: Results are illustrative only. Priority could be accorded the top ten markets without significantly changing the percentage of stations accommodated nationwide, but the availability of spectrum in nearby markets would be affected. For example, if additional stations in the Washington, D.C. market are accommodated, there would be less spectrum available in the neighboring Baltimore and Annapolis markets.

69. Receiver Study. Allotment of television channels currently is based on interference constraints that are implemented by requiring a minimum distance between stations. For example, stations using the same channel have to be separated by a certain minimum distance to prevent creating co-channel interference. Minimum separations also apply to adjacent channels since receivers generally are sensitive to signals immediately adjacent to the channel to which they are tuned.[103] In addition, the Commission's UHF allotment scheme also is based upon the characteristics of existing receivers that limit their ability to reject interference from undesired signals on certain other UHF channels. The interference mechanisms that produce this interference involve cross modulation, intermodulation, local oscillator frequency, intermediate frequency (IF) beat, half-IF beat, and image. These interference mechanisms generally result from undesired mixing or combining of signals in receivers. To avoid these limitations interfering with reception, our rules restrict the use of specific channels above and below each alloted UHF channel. These restrictions, known as the UHF taboos, substantially restrict the use of UHF channels.[104]

70. The OET receiver study analyzed the possible impact of ATV use of taboo channels on existing receivers by analyzing UHF immunity data on 15 conventional television receivers. Statistical methods were used to project the results for the existing domestic receiver population. It is important to note that the receiver data was based on NTSC format signals for both the desired and the interfering (undesired) signals. While the actual format that

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103 The minimum co-channel and adjacent channel separation distances for VHF and UHF stations are codified at 47 C.F.R. § 73.610 (1987) as follows:

Co-channel:

VHF Channels		UHF Channels	
Zone I	- 170 miles	Zone I	- 155 miles
Zone II	- 190 miles	Zone II	- 175 miles
Zone III	- 220 miles	Zone III	- 205 miles

Adjacent Channel (n + or -1):

VHF Channels	UHF Channels
60 miles	55 miles

104 These minimum separation distances are established by the UHF taboos, see 47 C.F.R § 73.698, Table IV (1987):

1) Intermodulation, cross-modulation and half-IF (n + or - 2, 3, 4, and 5 channels): 20 miles;
2) Local oscillator (n + or - 7 channels): 60 miles;
3) IF beat (n + or - 8 channels): 20 miles;
4) Sound image (n + or - 14 channels): 60 miles; and,
5) Picture image (n + or - 15 channels): 75 miles.

ATV augmentation signals will use is not known, the study assumed that the NTSC format represents a "worst case" interference situation. Therefore, we expect that an ATV signal designed to minimize interference would present less interference potential to conventional receivers than assumed in this study.

71. The results of the receiver study indicate that generally the first through fifth adjacent channels (n + or - 1 or 2, or 3, or 4, or 5) and sound image channels (n + or - 14) appear to be the best candidates for ATV augmentation. The IF beat phenomena channels (n + or - 7 or 8) appear to be somewhat less desirable for this purpose, and the picture image channels (n + or - 15) appear to be the least desirable. OET plans to conduct an additional study of the interference immunity of conventional receivers that will be based upon a more current sample of receivers.

72. The receiver study also considered the performance of an advanced technology receiver developed several years ago by RF Monolithics, Inc. The study concluded that the interference rejection capability of this receiver is substantially better than that of ordinary receivers, and that future NTSC or ATV receivers that incorporate similar technology would not require the UHF taboos protection.

3. Discussion

73. In considering the spectrum needs of ATV service, we believe it is desirable for all broadcasters to be able to participate in the provision of ATV service. We also believe it is important to avoid, to the extent possible, disruption of the existing broadcast television service provided to the public. We do, however, recognize that for technical reasons these goals may be difficult to achieve and that trade-offs may be necessary in the number of stations that can operate ATV service, the size of the geographic areas served by such stations, and the amount of spectrum available to each station.

74. With these considerations in mind, the studies by the Advisory Committee and our staff and the record developed in this proceeding support several tentative decisions that will allow us to focus our efforts regarding the spectrum to be used for ATV. In this section we address the area of the spectrum to be considered for ATV service, the spectrum plan for individual ATV channels, and our anticipated schedule for future action on ATV spectrum issues.

a. Spectrum To Be Considered for ATV

75. While we desire to authorize ATV service in a manner that would provide opportunity for all existing television stations to participate, based on the findings of the Advisory Committee and OET studies, we are not optimistic that this can be achieved easily. Nevertheless, we have tentatively decided to allot supplemental spectrum only within the existing VHF and UHF television allocation to provide for possible ATV transmissions.

We do not intend to consider spectrum outside these bands. There are a number of reasons for this tentative decision, as discussed below.

76. Frequency bands between 1 GHz and 13 GHz have been considered for ATV use. These bands are allocated to a variety of government and nongovernment services. Nongovernment frequency bands in this region are used heavily for broadcast auxiliary , cable TV auxiliary, common carrier, and private microwave fixed services. For each frequency band allocated to the fixed services there are generally between several thousand and upwards of forty thousand licensees or microwave paths. In most instances propagation conditions make it impractical to relocate these services to higher frequencies. Moreover, relocation would involve a severe detrimental impact on existing services, result in enormous expense, and could not be implemented without lengthy delays. The bands between 1 GHz and 13 GHz also are used for a variety of satellite services. The satellite services would experience problems similar to the fixed services if we were to relocate satellite services to other frequencies. An added problem is the time it takes to design, construct and arrange for launch of new satellites. Therefore it would be many years before existing satellites could be replaced and frequencies could be made available for ATV. Working Party 3 of the Advisory Committee's Planning Subcommittee generally arrived at these same conclusions, but identified three frequency bands for possible further examination for ATV: government frequency bands at 4.4-4.49 GHz (4 GHz) and 7.75-7.9 GHz (7 GHz) and the nongovernment DBS band at 12.2-12.7 GHz.

77. The 4 GHz band is allocated domestically for government fixed and mobile services. The government uses this band for high power military troposcatter systems intended for battlefield use. In peacetime the frequencies are primarily used for training on these systems. While the Advisory Committee feels this band may be attractive, this raises difficult national security issues and it is highly unlikely that the National Telecommunications and Information Administration would agree to relinquish or share these frequencies. We note there are more than 1300 assignments in this band. At the least, considerable delay would be involved before the frequencies could be made available. The 7 GHz band is allocated to a government fixed service. The Advisory Committee states that the intensity of use is unknown. Our review of this band indicates there are approximately 1000 assignments spread throughout the United States, used for a variety of vital government operations. For example, the Federal Aviation Administration uses this band to transmit remote radar data via microwave links to air traffic control centers. We conclude that there is little prospect that the 4 or 7 GHz bands could provide spectrum for ATV in a timely manner.

78. With regard to the DBS band at 12.2-12.7 GHz, we point out that DBS may be used today for conventional and ATV broadcast services. We note as an aside that the same also is true for the multipoint distribution services (MDS). Although the DBS service does not have any satellites in orbit today, the Commission has granted a number of permits, the permittees have shown due diligence in attempting to get the service in operation, and other parties

have applied for DBS authorizations. We are reluctant to disturb the nascent DBS service because of its potential to provide a multichannel television service to rural and underserved areas. Further, the technical problems, described below, associated with the use of microwave frequencies for ATV, are the most severe in the DBS frequency band. We also have considered the possibility of sharing the 12 GHz DBS band with ATV transmissions. However, it does not appear that this is a viable option. Satellite earth-station receivers need to detect weak signals from space and interference likely would occur from the relatively high power terrestrial ATV transmissions.

79. Irrespective of the issues involved in relocating existing services, we believe that there also are significant technical problems with the use of microwave frequencies for ATV. The propagation characteristics of microwave frequencies are not well suited to the reliable wide area coverage that we associate with broadcasting. Microwave signals are subject to shadowing from trees and foliage, obstruction by buildings, and attenuation caused by heavy rain. Line-of-sight paths are required generally. These propagation difficulties become greater at higher frequencies and would be more pronounced in the 12 GHz DBS band as compared to lower microwave bands.

80. There are additional problems with using microwave frequencies for augmentation. A separate microwave antenna would be needed to receive the augmentation signal, in addition to the normal UHF/VHF antenna. Further, transmitting augmentation signals on so widely separated frequencies as VHF and 12 GHz does not appear to be technically or economically feasible.

81. With regard to the availability of spectrum in the existing VHF and UHF bands, the studies indicate that an ATV system suitable for this purpose will have to be designed (1) to not be susceptible to NTSC UHF taboo interference,[105] and (2) to be both less susceptible to NTSC interference and not cause interference to NTSC stations at distances significantly less than those at which NTSC stations interfere with each other. As indicated above, we believe these assumptions to be technically feasible. Therefore, in considering authorization of systems that require supplemental spectrum, we will favor systems that are capable of operating within these constraints. This is not to minimize the practical difficulties that may be encountered as ATV systems are developed and implemented, but rather, to recognize the severe spectrum constraints that exist. We believe that interested parties should plan for and design systems capable of working within the limitations discussed above. We request comment on these conclusions, and if parties disagree with our conclusions, we request a detailed explanation for their positions and analyses of feasible alternatives.

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105 See Supra note 104 and accompanying text.

b. Spectrum Assignment Options

82. We intend to analyze ATV spectrum plans in terms of accommodating as many existing broadcasters as possible and encouraging the most intensive and efficient use of the spectrum. In view of the opportunity costs associated with spectrum used for ATV service, our preference is for ATV systems that can provide satisfactory service using the least spectrum. Because spectrum available for ATV use in the VHF and UHF broadcast bands is limited, we tentatively have concluded that we will consider only those plans that would use 6 MHz or less of additional bandwidth per station. Even if it were possible to eliminate or substantially relax the UHF taboos in an ATV environment and ATV receivers could handle signals with lower D/U ratios, authorization of supplemental spectrum in excess of 6 MHz would be undesirable because it would limit the number of stations that could be accommodated. Another element of our tentative decision is to maintain service to existing NTSC receivers, at least through a transition period, and therefore we do not intend to authorize ATV service that would result in a reduction to NTSC service. We propose requiring licensees to transmit an ATV signal that is compatible with NTSC receivers or to simultaneously transmit NTSC and ATV signals on dual channels. Therefore, any NTSC incompatible system that uses more than 6 MHz, such as the MUSE HDTV system, would not be a candidate for authorization.[106] We invite comment on these tentative decisions.

83. There are four basic options within the range of our tentative decision on spectrum: 1) no additional spectrum allotment; 2) 3 MHz of additional spectrum not necessarily contiguous to augment existing 6 MHz channels; and 3) 6 MHz of additional spectrum not necessarily contiguous for augmentation of the NTSC signal; 4) 6 MHz of additional spectrum not necessarily contiguous for transmission of a non-compatible ATV signal. We invite interested parties to comment on all aspects of these options. In particular, we seek information on service quality, equipment costs and other economic impact elements, and implications for spectrum efficiency.

84. Limitation of ATV systems to the 6 MHz bandwidth currently provided for television channels effectively would require that ATV systems be fully compatible with the NTSC system. As discussed in the comments and the economic analysis of the Advisory Committee, compared to other ATV alternatives, a 6 MHz compatible ATV system is expected to have only a relatively small economic impact on broadcasters, cable operators and consumers. Such a system would not require broadcasters to replace or add transmitters, nor would it require cable operators either to expand channel

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106 This conclusion is limited to VHF and UHF terrestrial broadcast television. We reiterate that nothing in this Further Notice is intended to suggest that we might restrict licensees in other services, such as DBS, from transmitting ATV signals with bandwidth of more than 6 MHz.

capacity or to discontinue any existing service. Existing receivers would be unaffected by the new signals and new ATV receivers would be able to process either NTSC or ATV signals. Limitation of ATV service to the existing 6 MHz channel also would permit future assignment of additional full service television stations, would not displace LPTV and TV translator stations that operate on a secondary basis, and might provide opportunity for additional non-broadcast use of the UHF band.

85. As was the case with color television, broadcasters' use of new, fully compatible technology likely would encourage the development and marketing of new receivers. High demand for ATV receivers, which reasonably could be expected with a fully compatible system, would allow manufacturers to quickly achieve economies of scale in production that would lead to lower prices for consumers. The availability of ATV programming for broadcasters and sales of ATV receivers likely would accelerate as broadcast stations and cable systems implemented ATV hardware. Thus, we believe that the transition to ATV might occur more rapidly than otherwise if a 6 MHz NTSC compatible ATV transmission option were implemented.

86. We recognize that the quality of ATV service that could be provided with a 6 MHz system may not be as high as that which might be possible with other system designs that use more bandwidth. At this point, the degree of qualitative improvement associated with systems that use greater bandwidth and the value consumers place on these improvements is not known. Thus, it is not clear whether broadcasters can remain competitive in the long run with the service quality attainable through a 6 MHz NTSC compatible ATV system.

87. Under the 3 MHz supplemental spectrum approach, an additional, not necessarily contiguous, augmentation channel would be authorized for ATV signals. A station would continue to transmit NTSC signals on its primary channel, and the 3 MHz augmentation channel would be used only by ATV receivers.[107] The primary desirable feature of this approach is that it likely would provide better ATV quality and facilitate an orderly transition to ATV service by maintaining compatibility with NTSC receivers. As indicated by the OET spectrum study, it also appears that a 3 MHz spectrum plan could accommodate more stations than a 6 MHz plan.

88. The expected improvement in service quality from use of the additional bandwidth would not be realized without costs, however. Broadcasters would incur the expense of additional transmitters, and cable operators would need to purchase new equipment or modify existing equipment to carry ATV signals and, in general, would have to either increase their channel

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107 The primary signal might carry information, perhaps on the vertical blanking interval, to indicate to an ATV receiver the frequency of the augmentation signal.

capacity or eliminate some existing services. In addition, use of additional spectrum might necessitate a significant reduction in the ATV service areas of many television stations, with the greatest reductions occurring in large cities, where station density is greatest. Use of a supplemental spectrum approach also would lock in the inefficiencies of NTSC for longer than a system not compatible with NTSC. Finally, assigning supplemental spectrum may be complex and costly, and it is not clear that successful ATV operation is technically feasible where there are large differences in frequency between the primary and supplemental channels. This may operate to the disadvantage of stations operating on the lower VHF channels.

89. Authorization of a supplemental 6 MHz would result in two possible ATV implementation scenarios. One would be to transmit augmentation signals. The advantage expected over a 3 MHz system would be greater improvement in service quality. The disadvantages of employing augmentation spectrum described above also apply. The other approach would be to use the 6 MHz to broadcast in tandem the signal of an independent, incompatible ATV system with the NTSC signal on the station's primary channel.[108] This might be desirable because after a transition period broadcasters could shift ATV transmissions to their primary channel and abandon NTSC transmissions if ATV receivers have sufficiently penetrated the market. Ultimately this would allow broadcasters to restore service areas to those under the existing allotment system. While we would expect broadcasters eventually to convert to ATV service, this option also would allow them to cease transmitting ATV service and continue to transmit NTSC service if sufficient demand for ATV does not develop. This process might be a way to implement ATV service relatively quickly with technical advantages that might be obtained from a system that need not be compatible with the NTSC system. If there were continuing demand for both NTSC and ATV service, broadcasters might operate both indefinitely. However, that would eliminate the spectrum efficiency benefit of ultimately regaining one of the two 6 MHz channels for other use. Parties addressing the simulcast approach are asked to comment on the likelihood of this occurring and its implications for spectrum efficiency.

90. The 6 MHz supplemental spectrum option generally is subject to the same types of costs and limitations as those of the 3 MHz option. However, as indicated by the results of the OET spectrum study, fewer existing broadcast stations could be accommodated with 6 MHz than with the 3 MHz option, with the greatest limitations occurring in the major cities. We seek comment on the desirability of authorizing 6 MHz of supplemental spectrum for ATV service and the effects this authorization might have on broadcasters, cable systems, consumers, and spectrum efficiency.

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108 Schreiber and NHK have designed systems that use 6 MHz bandwidths but are not compatible with NTSC receivers.

91. Assuming that use of more bandwidth permits transmission of better quality signals, we must compare the costs and benefits of using the spectum for enhancing television performance with increasing the number of NTSC stations or authorizing other competing uses for the same spectrum. The Advisory Committee is planning to assess the quality and economic impact of the various proposed systems. A framework for this analysis is contained in the Interim Report. In its report, the Advisory Committee's Planning Subcommittee Working Party 5 states that although it is not feasible to apply a complete quantitative cost-benefit analysis of policy decisions regarding ATV, the full enumeration of the direct and indirect costs and benefits and identification of those who gain or lose under each policy alternative should be analyzed.[109] We request comment on the costs and benefits of implementing ATV under the various spectrum options.

92. The OET study indicates that it may be possible to provide 3 MHz or even 6 MHz of additional spectrum to many authorized broadcast stations if the UHF taboos can be disregarded and more stringent interference protection criteria can be satisfied. However, it may be difficult or impossible to provide supplemental spectrum to all existing stations as presently allotted in a few of the most densely populated metropolitan areas, such as New York, Los Angeles, Philadelphia, Detroit and Washington, D.C. Therefore, it may be desirable to consider limited channel reassignments for a small number of stations if that would allow us to provide ATV spectrum to more stations than otherwise possible. Any such minor rearrangement of channel assignments would be designed not to significantly change the coverage area of the affected stations. We anticipate that generally such changes would involve changing a station's frequency by the least possible amount.

93. OET plans additional research to study the feasibility of such minor modifications to our Table of Allotments to determine if relatively minor changes would accommodate stations that otherwise might be unable to obtain additional spectrum. We ask for comments on the desirability of such an approach, how the costs might be apportioned, and on whether there are other ways to deal with the possible provision of supplemental spectrum if we conclude that we cannot satisfy every station in major urban areas.

c. Timetable for Future Action

94. We intend to conclude our technical analyses quickly, to develop a variety of channel assignment plans, and to present these plans for public comment as expeditiously as possible. At this juncture, we see little benefit in deferring spectrum decisions until we reach a decision on technical standards issues. We see benefits to proceeding rapidly. Inasmuch as the

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109 Advisory Committee, Planning Subcommittee Working Party 5, Report at 101 (May, 1988).

present allotments limit the amount of spectrum capacity available for assignment, proposing band plans early in the process will identify real design constraints that may both narrow the number of systems under consideration and assist system designers to develop ATV formats that can be used under actual broadcast conditions. Also, determining whether there will be supplemental assignments and, if so, the viable set of such assignments may permit relaxation of our freeze on television allotments and assignments.

95. In summary, we request comment on the availability and use of spectrum for ATV as discussed above. In addition to our tentative conclusions, parties should address any other relevant issues involving spectrum availability and use.

C. UHF Freeze and Private Land Mobile Sharing

96. We have considered methods to amend or repeal either the UHF freeze or our deferral of action in the proceeding that considers additional sharing with the private land mobile radio service (PLMRS)[110] but have concluded that taking any action at this time would be premature because inevitably it would affect the options available for providing ATV service within the existing broadcast allocations. Therefore, although we wish to resolve these issues as soon as possible so that spectrum can be utilized to provide service to the public, we are unable to do so now. However, as discussed herein, we intend to conclude our technical analyses and develop a variety of channel allotment plans. Once these plans are adopted, we will be in a position to relax or repeal the television freeze and to assess the public interest utility of the PLMRS sharing proposal.

D. Relay Services

97. If broadcast ATV utilizes a bandwidth greater than 6 Mhz, there may be a need for additional spectrum for ATV signals to be distributed to stations via satellite, for studio to transmitter links (STL), and for TV pickup and cable relay services (CARS).[111] Since successful implementation of a wideband ATV system may depend upon modification of the existing signal delivery systems, we seek comment on the adequacy of the existing allocated bands used to deliver television signals and the ability of current delivery mechanisms to handle ATV signals.

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110 See ¶ 7, supra.

111 While it is possible that some 6 MHz ATV systems will require a higher signal to noise ratio than NTSC, they would not require a change in the signal delivery bandwidth.

98. As an initial matter, it appears that satellite delivery to stations and cable systems could be accomplished employing either the Fixed-Satellite Service (FSS) or the Broadcasting-Satellite Service (BSS). Working Party 4 of the Advisory Committee's Planning Subcommittee opined that the excess of FSS spectrum-orbit supply over demand will continue for some time. If there is excess capacity in the FSS, fixed satellite distribution of ATV signals with a baseband greater than 6 MHz would be feasible.[112] C-band satellite transponders used for video distribution generally are available in 36 MHz increments[113] which, employing FM modulation, could provide a high quality distribution signal for a 9 MHz baseband ATV terrestrial system. A 12 MHz system, however, might require the wider channels available at Ku-band.[114] The BSS will employ the 12.2-12.7 GHz band. Although internationally it is planned to accommodate 24 MHz transponders, it could accommodate wider bandwidth channels since no U.S. DBS satellite has been launched yet.[115]

99. The existing STL and TV pickup links generally employ the 2 and 6 GHz bands, using FM modulation in 17 and 25 MHz channels, respectively. Working Party 3 of the Advisory Committee suggested that these bands may require wider channels for ATV, which would result in correspondingly fewer channels being available.[116] We note that using FM modulation, a 25 MHz channel might be adequate for a 9 MHz ATV signal, and therefore no change may be necessary in the 6 Ghz band. Also, digital modulation systems might improve usage. Higher bands such as 17.705-18.135 GHz also are available and less congested, so it may be possible to stack existing channels or rechannelize to permit ATV use. However, this approach may not be practical

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112 See Advisory Committee, Planning Subcommittee Working Party 4 Report, section 4.3 at 9 (May, 1988).

113 Id. section 4.3 at 2

114 The bandwidth of Ku band FSS transponders typically is 54 MHz, but may be as wide as 72 MHz. A number of system operators transmit two channels of video (6 MHz baseband) through a single 44 or 54 MHz channel. See Id., section 4.3 at 9.

115 The international Plan (RARC-83) provides the U.S. with 32 interleaved channels (16 on each polarization) at each of eight orbital positions. ATV could be accommodated by expanding channel bandwidth or by combining channels. See e.g. DBS applications of United States Satellite Broadcasting Co., Inc. (DBS-88-06-MP) and Hughes Communications Galaxy, Inc., (DBS-88-07-MP). Of course, combining of 24 MHz channels to transmit these wider formats would reduce the overall number of channels available.

116 Advisory Committee, Planning Subcommittee Working Party 3, Report at 44-45.

for the longer STL links because more hops would be required than at 6 GHz, due to the greater attenuation experienced at higher frequencies.

100. Since the bands available for STL, TV pickup and CARS operations already are highly congested in some urban areas, we seek comment on whether they are sufficient to accommodate ATV and suggestions for increasing their capacity. Also, we solicit comment on methods to accommodate wider bandwidth ATV signals within the existing bands, the technical feasibility of employing the higher microwave bands to satisfy auxiliary broadcasting requirements for ATV in areas of high spectrum occupancy, and the costs associated with doing so. In addition, we solicit comment on any additional alternatives, including 1) suggestions for any additional frequencies that may be used and 2) the availability and practicality of utilizing non-spectrum technologies and services such as those provided by wireline common carriers for these purposes.

101. Cable system signal distribution also will be affected by wider bandwidth ATV. In the most heavily used CARS band, at 12.7-13.2 GHz, usage consists primarily of amplitude-modulated links (AML) relaying blocks of 6 MHz NTSC television channels. The report of the Advisory Committee's Planning Subcommittee Working Party 3 on Spectrum Utilization states that additional spectrum would be necessary to carry the greater bandwidth of ATV signals.[117] The report of Planning Subcommittee Working Party 4 estimates that an AML transmitter retrofit to support transmission of wider bandwidth ATV signals would cost approximately $13,000 per channel.[118]

102. Comment is requested on this conclusion, on the feasibility of using allocated bands higher in the spectrum at 17 GHz and 19 GHz, and on other related problems and solutions. We also seek comment on the implications for the satellite services of wider bandwidth ATV signals that would have to be distributed to both broadcast stations and cable systems.

E. Border Areas

103. Television signals broadcast in border areas are subject to bilateral agreements with Canada and Mexico. In the case of Canada, the border area is defined as the area within 400 km of the boundary.[119] The border area

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117 Advisory Committee, Planning Subcommittee Working Party 3, Report at 46.

118 Advisory Committee, Planning Subcommittee Working Party 4, Report at section 4.2 at 5. The basis for this estimate is the cost of adding NTSC channels. Making this change would effectively lower the maximum power per channel, which would result in either a shorter path or increased probability of signal degradation during periods of heavy precipitation.

119 *Working Arrangement for Allotment and Assignment of VHF and UHF Television*

with Mexico is defined as being within 400 km of the boundary for VHF and 320 km for UHF.[120] Since these agreements are based upon the existing 6 MHz channelization scheme, it will be necessary to enter into discussions with Canada and Mexico to provide for the implementation of ATV within the border areas if, in the view of either signatory, the technology requires different interference considerations than those provided by the agreements. In particular, we note that the treaties not only incorporate tables based upon the existing 6 MHz channelization scheme, but also provide for employment of offset carriers to reduce interference. Use of the presently allocated broadcast spectrum within the border areas as defined by the agreements will require discussion between the governments involved, particularly if spectrum is reassigned, or if ATV systems employ different carriers or other changes to current standards that would increase the potential for interference. We note that Canada and Mexico have shown interest in ATV.[121] We look forward to the reports of both the Planning and Implementation Subcommittees on this matter. The former group is planning to perform the computer planning studies, and the latter group is planning to evaluate the effect of ATV implementation on U.S. treaty obligations.

104. On the Canada/U.S. boundary, the close proximity of cities is of particular note. The existing agreement provides for locating stations at less than the minimum agreed co-channel separation, so as to provide an adequate number of stations for nearby cities of each country. The Working Arrangement, supra, considers that objectionable co-channel interference would exist only when the F(50,10) field strength values at the protected contour exceed the appropriate maximum F(50,10) field strength given in Table I of that Arrangement. Table I provides a D/U ratio of 9-18 dB for different specified channels employing offset carriers. Since the nominal value of D/U expected using offset carriers is 28 dB, the effect is to reduce service distance in the various cases so as to permit location of co-channel stations

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Broadcasting Channels Under the Canadian-U.S.A. Television Agreement of 1952 (1968) see 3 UST 4443, as amended.

120 United States-Mexico VHF Television Agreement (1962) and Agreement between Mexico and the United States Concerning UHF Television Channel Assignments (1958), 13 UST 997, as amended.

121 Canada has been an active participant in the deliberations of T3, a subcommittee of the ATSC considering HDTV. Televisa, a Mexican corporation engaged in television networking and broadcasting in the Republic of Mexico, submitted a Statement of Interest in response to the NOI indicating that it considers the conclusions reached and the standards adopted in this proceeding will affect broadcasting in Mexico and that it intends to participate in the Advisory Committee subcommittees and working parties.

closer together. This provision has enabled both countries to satisfy their requirements in the border area.

105. We request comment on the specific application and effect of these Agreements under the possible ATV scenarios. We also request analysis of the interference potential of the proposed systems as related to the obligations of the United States under these bilateral agreements, suggestions for how the interference potential might be minimized, and how this may be accomplished for each of the proponent systems.

IV. ATV STANDARDS

A. Introduction

106. Technical standards in broadcasting, such as the NTSC standard for television signals,[122] have been established in order to ensure compatibility between transmission and reception, to control interference, to facilitate efficient spectrum use, and to ensure signal quality. In this section we consider the following issues related to establishment of ATV standards: (1) whether the existing NTSC standard should be relaxed or repealed; (2) how standards should be established for ATV; and (3) whether it would be desirable to require compatibility between ATV broadcast transmissions and other ATV distribution media, such as cable and videocassette recorders.

B. Relaxation or Repeal of the NTSC Standard

1. Positions of the Parties

107. In the NOI we solicited comment on whether the NTSC transmission standard should be relaxed or repealed to facilitate the introduction of ATV systems. The comments in general oppose any modification of the NTSC standard. MST states that alteration of the NTSC standard would be premature and unlikely to facilitate the introduction of ATV service because ATV systems are not fully developed, but only have operated on an experimental basis.[123] According to MST, the results of testing and evaluation now underway will assist in determining whether new standards are desirable and, if they are, the characteristics that should be included. NAB adds that the Commission's rules provide for experimentation without relaxing the generally applicable NTSC transmission standard through special temporary authority or experimental authorizations under Part 74, and that amendment of the NTSC standard on an as needed basis to accommodate a particular system would provide a more orderly transition than a general relaxation.[124] GE also opposes modification of the standard, and warns that poor television receiver performance might result if the NTSC standard were relaxed or repealed because receiver designers would be unable to anticipate the conditions under which new receivers would be required to perform.[125]

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122 We codified the NTSC color standard in Amendment of the Commission's Rules Governing Color Television Transmissions, 41 F.C.C. 658 (1953), see 47 C.F.R. §73.682 (1987).

123 MST Comments at 54.

124 NAB Comments at 19 - 20.

125 GE Comments at 14.

108. NYIT states that ATV undoubtedly will require modification to the NTSC standard, but that changes should be made only if they do not degrade reception by NTSC receivers, are agreed to by the broadcast industry, and are not mandatory.[126] RTT also favors relaxation of the NTSC standard, at least to the extent necessary to allow implementation of its T-NET system, which it claims permits one-way communication between subscribers and stations. RTT argues against freezing the development of television technology while ATV systems and standards are developed.[127]

2. Discussion

109. We agree with most of the commenting parties that because ATV systems still are in the developmental stage, little would be gained by eliminating or relaxing the NTSC standard at this time. However, we do find it in the public interest to develop an interim policy to consider requests for waivers of the NTSC transmission requirements for the purpose of broadcasting ATV signals.[128] We intend to act on such requests expeditiously, provided that they meet the following conditions: (1) the public's reception of existing stations will not be impaired; and (2) interference to other stations will not exceed that caused by the station's present NTSC operations. If these conditions are not demonstrated, we will require a complete explanation of any interference expected and why grant of the requested waiver would further the public interest. Comments are requested on this decision and on the proposed waiver criteria.

C. Establishment of ATV Standards

1. Positions of the Parties

110. The comments indicate that broadcasters prefer that the Commission select a single mandatory ATV transmission standard. NAB agrees that

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126 NYIT Comments at 22.

127 RTT Comments at 8. We do not address the merits of the T-NET proposal because it is outside the scope of this proceeding concerning ATV.

128 We have received a number of informal inquiries regarding possible changes to the NTSC standard that would, it is argued, eliminate obsolete provisions or modify the standard to improve signal quality. We encourage attempts to improve the existing NTSC system, and, upon receipt of formal proposals, we will act promptly to process requests for waivers and experimental authorizations, or take whatever other measures may be appropriate. In evaluating these requests, we intend to apply the same criteria discussed in this paragraph.

standards are necessary, but recommends that we endorse a standard chosen by industry rather than formulate a standard on our own.[129] GE argues that the Commission must take a leadership role in establishing a standard because not to do so could be confusing, reduce the rate of ATV implementation, or even result in consumer rejection.[130]

111. MST states that compatibility with existing NTSC receivers should be an important part of a standard, but that too little technical information is available on ATV transmission methods to select a particular standard at this time.[131] SBCA also states that it would be premature to set standards at this time.[132] NTIA argues that to avoid a protracted struggle over standards we should pick a standard within three years that is as spectrum efficient as possible.[133] NTIA proposes that we compare the quality of various systems but rely on industry thinking in selecting ATV standards.

112. Other commenters point out disadvantages of government standards-setting for ATV. Neuman emphasizes the delay inherent with government regulation, and proposes as an alternative industry negotiation and agreement without our formal adoption of standards.[134] Similarly, SBCA argues that the market should be as free of standardization as possible to allow consumers to be the ultimate decisionmakers and suggests that standardization may limit innovation and creativity, prevent development of the best possible system, and result in higher costs.[135]

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129 NAB Comments at 7.

130 GE Comments at 10.

131 MST Comments at 56.

132 SBCA Comments at 4.

133 NTIA Comments at 6. In a recent speech Alfred Sikes, Deputy Assistant Commerce Secrtary and head of NTIA, stated that based on studies done by MIT and NTIA, he no longer believes we must act so quickly to avoid being overtaken by imported technology. While he continued to recommend that the FCC set a standard, he urged that it not be set in a preclusive way. Broadcast Magazine, June 6, 1988 at 30.

134 Neuman Comments at 5.

135 SBCA Comments at 4.

2. Discussion

113. While we agree that it is premature to adopt an ATV standard at this time, we also believe that the public interest compels a Commission role in the development of standards with the advice and involvement of all sectors of the industry. Establishing standards has the advantage of pointing the various interested parties -- researchers, equipment manufacturers, broadcasters, networks, and program producers -- in the same direction and reduces the risk to both audiences and broadcasters of investment in an ATV system that might become obsolete if a different system is introduced in the market. Thus establishing a standard may overcome audiences' and broadcasters' reluctance to invest in ATV technology by increasing the amount of programming available to audiences and ensuring that receivers will be compatible with broadcast signals. Standards also may increase demand for equipment, leading to economies of scale in equipment manufacture that will lower costs to the public.

114. The characteristics of a well defined emission standard also can be used as assignment tools to provide greater opportunities for efficient spectrum use. For example, even though our NTSC interference protection criteria are based on a nominal 45 dB desired to undesired (D/U) ratio, by taking advantage of the structure of the NTSC signal we found that offsetting frequencies of co-channel stations by 10 kHz permits protection ratios to be reduced to 28 dB D/U without reducing reception quality. Options for dealing in a similar manner with the additional interference caused by transmitters operating on supplemental spectrum might be reduced if different ATV systems exist, since establishing standard offset carrier frequencies would not be possible. Given the apparent difficulty of providing supplemental spectrum to all licensees, this is an important consideration. However, this would not necessarily be our conclusion for all types of ATV systems. Achieving spectrum conservation through setting technical standards may depend upon the technology chosen.

115. Despite these advantages, detailed, inflexible standards that have the force of law may reduce consumer choice and prevent the timely introduction of new technology. We do not believe that any action we take should preclude the future improvement of ATV systems nor discourage the development of newer and technically superior ATV systems. We concur with the report of Working Party 5 of the Advisory Committee's Planning Subcommittee that "[if] there is a general prescription for agency involvement, it would be to preserve flexibility in the standard setting process to the greatest extent possible."[136] Accordingly, we wish to consider ways in which flexibility for such future improvements can be taken into account.

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136 Advisory Committee, Planning Subcommittee Working Party 5, Report at 97 (May, 1988)