

discretion carriage of only “*non-program-related*” advertiser supported information services.

AT&T also attempts to add its gloss to the concept of “program-related” by suggesting that the *WGN* test is appropriate because it captures only material that is “an essential part” of the broadcaster’s primary video programming. *Id.* at 28. But nowhere in FCC decisions is there an “essential part” test. Rather than narrowing the definition of program-related as cable suggests, digital television needs a broader definition for 68% of consumers to receive content related to the broadcasters’ programming service.

AT&T, NCTA and Time Warner also have concluded that cable is not required to carry *any* program-related content unless it is *in* the primary video feed.⁹⁷ Thus, cable operators boldly states that they should be allowed to limit “program-related” carriage obligations to closed captioning, V-chip program ratings data, Nielson ratings data, and PSIP channel mapping data,⁹⁸ thus eliminating all advanced digital capabilities, including zoned newscasts and “intrinsically” related interactive content. These cable comments speak volumes as to why cable operators cannot be left with making determinations as to what constitutes “program-related” for must carry purposes.

Further, TWC contends that Section 614’s reference to “program-related material in the VBI and subcarriers” is an explicit statutory limitation to only material “in a VBI.” Comments of TWC at 29-30. Since in digital, there is no VBI, TWC asserts that the FCC should find that no material outside the primary video feed is entitled to carriage. TWC, ironically, asks the Commission to ignore the plain language of Section 614 that a cable

⁹⁷ Comments of AT&T 29; Comments of NCTA at 27; Comments of TWC at 10.

⁹⁸ Comments of AT&T at 29-30; Comments of NCTA at 27; Comments of TWC at 30.

operator shall carry the primary video *and* program-related material.

Nor is the cable industry willing to accept advanced sports programming as program-related.⁹⁹ But contrary to NCTA's statement,¹⁰⁰ enhancements of sports programming with statistics, multiple camera angles, playing along with a game, etc. are not "speculative examples" of digital technology. Participation of the National Hockey League ("NHL"), the PGA Tour, Inc. ("PGA") and the National Football League ("NFL") in this proceeding contradicts this. Indeed, professional sports have asserted their active interest in "preserv[ing] and increase[ing] the value of their proprietary sports event programming" through advanced digital television services. Comments of NHL at 6, Comments of NFL at 3. NAB/MSTV/ALTV agree with the Commission that "[w]ith the advent of digital television, broadcast stations now have the opportunity to include in their video services a panoply of program-related content" and that "[t]he statute contemplates and our rules require that cable operators provide mandatory carriage for this program-related content." *Report and Order* at ¶ 57. Advanced sports programming enhancements even clearly fit within the four corners of the *WGN* test for program-relatedness.

But ICCP claims that over-the-air enhanced sports programming is beyond the "appropriate definition" of program-relatedness and that its introduction would come at the expense of "other, less constitutionally suspect uses that subscribers may prefer, such as additional cable program networks." Comments of ICCP at 16-17. Of course, what ICCP and other cable providers would rather see is sports programmers choosing to

⁹⁹ See Comments of NCTA at 27; Comments of ICCP at 15; Comments of Starz at 16; Comments of TWC at 29.

¹⁰⁰ Comments of NCTA at 26.

distribute their intellectual property over cable networks, which of course is what sports programmers would have to do if free over-the-air advanced programming services are denied carriage to over two-thirds of the audience. *See* Comments of NFL at 6-7.

Further, NCTA's claims that carrying program-related material such as multiple camera angles of sporting events would consume "one additional channel for each camera angle" wildly overstates the carrying capacity required. Comments of NCTA at 30. As NCTA well knows, a DTV signal uses no more than 19.4 megabits, regardless of whether it includes one program, multiple programs, data, or any other services. In fact, cable operators can carry the entire 6 MHz broadcast signal (including all multicasts and/or multiple camera angles) in 3 MHz of digitized cable spectrum. *See* MWG Report at 12-13.

Moreover, NCTA's point that allowing such material to be considered program-related might "come at the expense of" additional cable programming¹⁰¹ overstates cable's ability to utilize "extra" spectrum and still be at the ready to carry all program-related material and the next feed of HDTV that will require carrying the entire 19.4 Mbps of the broadcast signal.¹⁰²

Notably absent from the cable industry's comments is any indication they will carry Electronic Program Guides (EPGs). We agree with Gemstar that, as viewers choices expand in a digital and interactive environment, EPGs will become "indispensable to viewers attempting to enjoy and manage the full range of services and content." Comments of Gemstar at 10. We also concur with the CEA that PSIP *and*

¹⁰¹ Comments of NCTA at 34.

¹⁰² *See* NAB/MSTV/ALTV Petition for Reconsideration and Clarification, CS Docket No. 98-120, April 25, 2001 at 20.

other information delivered in the video stream, must be considered “program-related.” PSIP includes a mass of information pertaining to tuning, V-chip, closed captioning, program guides, emergency information alerts. Without that information, many features of digital television receivers will not be usable, and PSIP information is directly analogous to captioning and stereo information that the Act directs to be carried. Comments of CEA at 9.

Finally, NAB/MSTV/ALTV is confident that broadcasters’ deployment of advanced television services will be “technically feasible” as defined in the *Must Carry Order*.¹⁰³ Since more than 68% of American households access broadcast programming through their cable systems, it makes little sense for the broadcast industry to develop program-related content that cannot be transported easily over a cable system.¹⁰⁴

VI. Carriage of Digital Signals By Satellite Carriers

In its Comments, NAB/MSTV/ATLV suggested a sensible middle course for the Commission on the issue of carriage of digital signals by Direct Broadcast Satellite (“DBS”) firms: that the Commission should comply with the Act by requiring carriage of “all” local television stations, whether analog or digital, but should phase in the obligation by DBS firms to carry digital as well as analog stations. NAB/MSTV/ALTV Comments at 41-43.

The comments filed by the satellite industry and its allies in this proceeding provide no basis for the Commission to reject the prudent course proposed by NAB/MSTV/ALTV. EchoStar’s Comments, for example, are largely based on the

¹⁰³ *Must Carry Order* at 2986

¹⁰⁴ See Comments of NCTA at 39.

supposed unconstitutionality of the carry-one-carry-all principle adopted by Congress in the Satellite Home Viewer Improvement Act (“SHVIA”).¹⁰⁵ Comments of EchoStar Satellite Corporation at 1-4. But only a few days after EchoStar filed its Comments, the United States District Court for the Eastern District of Virginia, in a comprehensive 64-page opinion, squarely rejected the satellite industry’s constitutional attack on the SHVIA, ruling that “the SHVIA is constitutional and does not in any way violate the First and Fifth Amendment rights of satellite carriers.” *SBCA v. FCC*, Civ. No. 00-1571-A, slip op. at 3 (E.D. Va. July 19, 2001). The Court thus reaffirmed the Commission’s correct conclusion in this proceeding -- which the Commission has now reiterated many times in court -- that SHVIA easily satisfies all relevant constitutional standards. *See Report & Order*, CS Docket No. 00-96 at ¶¶ 10-13 (Nov. 29, 2000).

Under the SHVIA, of course, satellite carriers are not required to carry any television stations whatsoever, whether in analog or digital format. Rather, satellite companies are obliged to carry the full range of local stations *only if they make use of the new local-to-local compulsory license* to carry at least one station. For that reason, the channel capacity of EchoStar and other satellite carriers is irrelevant to the satellite industry’s constitutional claim. EchoStar nevertheless continues to belittle its capacity to carry television programming, *see* EchoStar Comments at 2, 4-5, even as it prepares to launch spot-beam satellites (which will enormously increase the efficiency of its delivery of local stations) and even as it works to expand its already vast Ka-band capacity (which can be used to deliver enormous numbers of TV channels, including digital channels).

¹⁰⁵ Rather than filing new Comments, DirecTV’s June 11, 2001 Comments simply incorporate by reference its prior filings. NAB likewise incorporates by reference its prior filings in CS Docket No. 00-96, including its responses to DirecTV’s prior submissions.

The truth is that EchoStar and DirecTV are perfectly capable of delivering both analog and digital signals in all of the markets they would otherwise choose to serve. Any supposed capacity constraints can be easily overcome, as illustrated by the plans of Local TV on Satellite, Inc. (“LTVS”) -- which, using only two Ka-band satellites, proposes to deliver a full 19.4 Mbps digital signal in 65 markets, or some 25 more markets than either DirecTV or EchoStar serves today. *See* LTVS web page, www.localtv-satellite.com. Whether or not EchoStar and DirecTV eventually enter into a business partnership with LTVS, the DBS firms could individually -- or, even more efficiently, jointly -- do the same thing that LTVS has proposed. Prospects for Ka-band local-to-local service are now brighter than ever, since the Commission has just issued second-round Ka-band license to 11 companies, including DBS distributor Pegasus Development Corporation and DirecTV corporate affiliate Hughes Communications, Inc. (These second-round authorizations are on top of the slots already allocated to DirecTV and EchoStar (or their affiliates) in the first round.) As the Commission observed on approving the second-round licenses, “[t]hese advanced [Ka-band] satellite systems will enhance competition among service providers in the marketplace and provide new service options to the American public.” News Release, *FCC International Bureau Authorizes Second-Round Ka-Band Satellite Systems* (Aug. 2, 2001). In the wake of the Commission’s second-round award, one of the new Ka-band licensees, Pegasus Development Corporation, announced that the new licenses will enable Pegasus to provide a variety of services, including “*re-transmission of local broadcast signals . . . to communities throughout North America.*” Pegasus web site, www.pgvtv.com (visited Aug. 13, 2001) (emphasis added).

Alternatively, if they preferred, the DBS firms could double their capacity to carry local stations using Ku-band frequencies by creating a local-to-local cooperative (either through LTVS or otherwise) that would deliver local stations to both EchoStar and DirecTV subscribers, rather than having EchoStar and DirecTV wastefully duplicate the uplinking and downlinking of the identical signals. Alternatively, the DBS firms could exploit the vast amount of Ku-band capacity available at “wing slots” (such as 61.5° W.L. and 148° W.L.) or expand their capacity at both Ku-band and Ka-band slots by exploiting the power of available techniques such as 8PSK modulation. By setting a medium-range deadline for the effective date of the requirement to carry both analog and digital signals, the Commission can create the necessary incentive to encourage satellite carriers to take the technical steps (such as launch of additional satellites) that will enable them to carry both the analog and digital signals of all stations during the digital transition period.

The comments filed by other parties add little to EchoStar’s filing. The Satellite Broadcasting & Communications Association, for example, asserts that there is “no statutory authority” for the Commission to impose a dual-carriage requirement on satellite carriers under the SHVIA. SBCA Comments at 3 (filed June 11, 2001). That claim, however, is readily rebutted by a glance at the Act, which calls for carriage of “*all* television broadcast stations” -- not merely analog TV stations -- by carriers that rely on the local-to-local compulsory license. 47 U.S.C. § 338(a)(1).

Two commenters (Starz Encore Group LLC and International Cable Channels Partnership, Ltd.) make the same puzzling assertion: that “in general, any local broadcast station carried by . . . a DBS operator must be carried nationally.” Starz Encore Group

LLC Comments at 21 (filed June 11, 2001); International Cable Channels Partnership, Ltd. Comments at 19. That assertion is wrong: both DirecTV and EchoStar have recognized that using CONUS satellites to deliver local channels is not a sensible proposition as a general matter, and have therefore made plans to launch spot beam satellites to deliver most, if not all, of the local channels they carry.

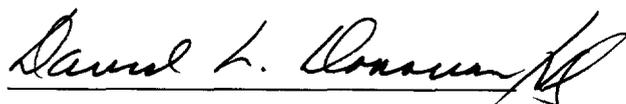
In short, the Comments filed by the satellite industry and its allies do nothing to undercut the sound, compromise solution proposed by NAB/MSTV/ALTV in their initial Comments.

Conclusion

Try as they might, cable commenters proffering in the main a re-hash of previous arguments cannot escape certain obvious conclusions in this proceeding. They are: cable operators, in nearly all markets, are nearing completion of a massive extension of cable system carrying capacity which will accommodate the temporary addition of DTV signals with minimal burden, mandatory must carry of DTV signals is necessary to a swift, successful transition of free, over-the-air broadcasting to digital technology and, absent an expeditious and successful DTV transition, Congress' goal of preserving the vitality of the free, over-the-air broadcasting system for all viewers will be endangered. The FCC's choice in this regard should be clear: the prompt adoption of a digital must carry rule.

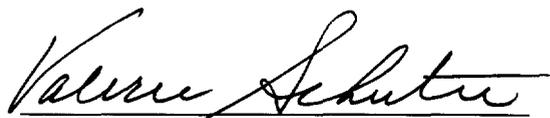
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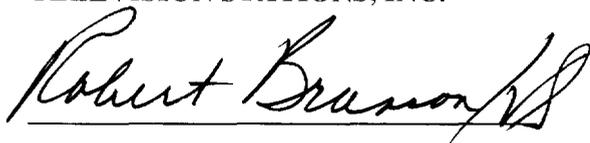
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August 16, 2001

APPENDIX A

**ANALYSIS OF
CABLE OPERATOR RESPONSES
TO FCC SURVEY OF CABLE MSOs**

**Prepared for
the National Association of Broadcasters**

**Prepared by
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August 14, 2001

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Analysis of Cable Operator Responses to FCC Survey of Cable MSOs

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Executive Summary

Analysis of the responses to the recent FCC survey of cable system operators entitled "Questions on Cable System Capacity and Retransmission Consent Agreements" reveals significant growth in the capacity of cable television networks. That growth is projected by the cable operators' data to continue through the period covered by the FCC's survey, i.e., from yearend 1999 through yearend 2003, providing both historical information and future expectations of the respondents. Twelve companies of varying sizes provided the data.

Review of the cable operators' data demonstrates growth in several areas. Respondents projected that bandwidth provided to the average subscriber for downstream delivery of television programs would grow by 103.25 MHz during the period. At the same time, total bandwidth that will be provided to the average subscriber was projected to reach 725.2 MHz. By the end of the period, 86 percent of subscribers were projected to receive 750 MHz or greater bandwidth service, with almost 12 percent receiving 860-870 MHz service.

Applying the cable operators' estimates of the number of programs that can be carried in the various forms of digital channels, the number of program services that cable operators will be able to deliver will rise by a minimum of 83.5 percent during the period, with the potential increase over 100 percent. The result is delivery to the average subscriber at yearend 2003 of between 261.8 and 295.7 program services, depending upon the type of modulation used. These results are after allowing for upstream transmission and the downstream portions of two-way services such as telephony and cable modem service. They also account for the lower number of services per channel when delivering HDTV.

The "burden" placed on the cable industry by carriage of commercial television stations has declined from 13.35 percent of downstream bandwidth in 1993 to 6.25 percent at the end of 1999 in the average DMA. That value can be expected to rise to 8.46 percent at the end of 2002 with the addition of DTV signals for each commercial television broadcaster then gradually begin to taper off. By the completion of the cable operators' upgrades sometime after 2003, the "burden" from carriage of both analog and digital commercial broadcast services will decline to 7.88 percent. At the conclusion of the transition to DTV, the portion of downstream bandwidth to the average subscriber devoted to commercial broadcast signals will drop to 2.63 percent in the average market.

Conservative factors were applied in the analysis of the operators' data. This means that the potential exists for even greater growth by the cable industry than disclosed above, which would result in a reduced burden on the cable industry from that calculated for carriage of both analog and digital services. The possibilities for further improvements in cable capacity as a result of technological advances are considered in the report. Consideration is also given to the impact of public television (non-commercial educational) stations on the bandwidth needed for broadcast signal carriage.

Introduction

In its Further Notice of Proposed Rulemaking in CS Docket No. 98-120, In the Matter of Carriage of the Transmissions of Digital Television Broadcast Stations, the Federal Communications Commission indicated its intention to survey cable operators to learn of their system capacities. This was intended to allow the Commission better to evaluate the capability of cable systems on a nationwide basis to carry the Digital Television (DTV) signals of the terrestrial broadcasters it licenses.

The survey sent to cable operators was titled “Questions on Cable System Capacity and Retransmission Consent Agreements.”¹ It contained four Questions. They sought: (1) information on the number of subscribers served by all of the systems of each responding operator and estimates of the percentage of subscribers served by systems of specified bandwidth capacities by year, (2) a breakdown of the capacity usable for downstream transmissions into analog video, digital video, and other services of the largest representative systems of each operator in each of five bandwidth categories by year; (3) information on the digital modulation techniques intended for use, a further breakdown of the expected use of digital modulation bandwidth for carriage of HDTV and SDTV programs, and the number of such services anticipated per 6 MHz channel, by year, and (4) detailed information, both technical and non-technical, on any retransmission consent agreements already concluded and on any in negotiation. The survey sought responses in the form of tables to be completed by the system operators.

Responses were received by the Commission from twelve organizations (listed here in alphabetic order): Adelphia Communications, Armstrong Cable Services, AT&T Broadband, BellSouth Interactive Media Services, CableOne, Cablevision Systems, Charter Communications, Comcast, Cox Communications, Insight Communications, RCN Corporation, and Time Warner Cable. Some of the responses provided completed tables as sought by the Commission, some provided only narrative responses, and some were combinations of the two forms of response.

The National Association of Broadcasters (NAB) retained the Merrill Weiss Group to review the responses, to develop a statistical analysis of them to the extent possible, and to put into perspective the system capacity indicated by the survey responses and the technology bearing upon that capacity that system operators can be expected to have available as a resource over time. This report seeks to present such an analysis in a manner that can inform the deliberations of the Commission as it considers the issue of DTV Must Carry.

¹ OMB Approval No. 3060-0935, Expiration Date December 31, 2003.

Survey Responses and Statistics

As described above, responses to the FCC survey were received from twelve system operators. Some completely filled in the tables supplied by the Commission with the data requested. Others partially filled in the tables with the requested data, while others partially filled in the tables with data related to what had been requested. Still others provided no tabular response, opting instead to provide narrative discussion with some of the requested data included therein. One organization refused to let most of its information be seen by the public, marking virtually all of the tables as “redacted.”

Question 1 — System Bandwidth vs. Time

As a consequence of this variety of response formats, combined with the lack of completeness in many of the responses, obtaining a statistical analysis of the survey results is difficult. Nevertheless, rather revealing data can be obtained in some areas with sufficient examination. This is particularly true with respect to system bandwidth over time, as sought by Question 1 of the survey (and termed “capacity” therein).

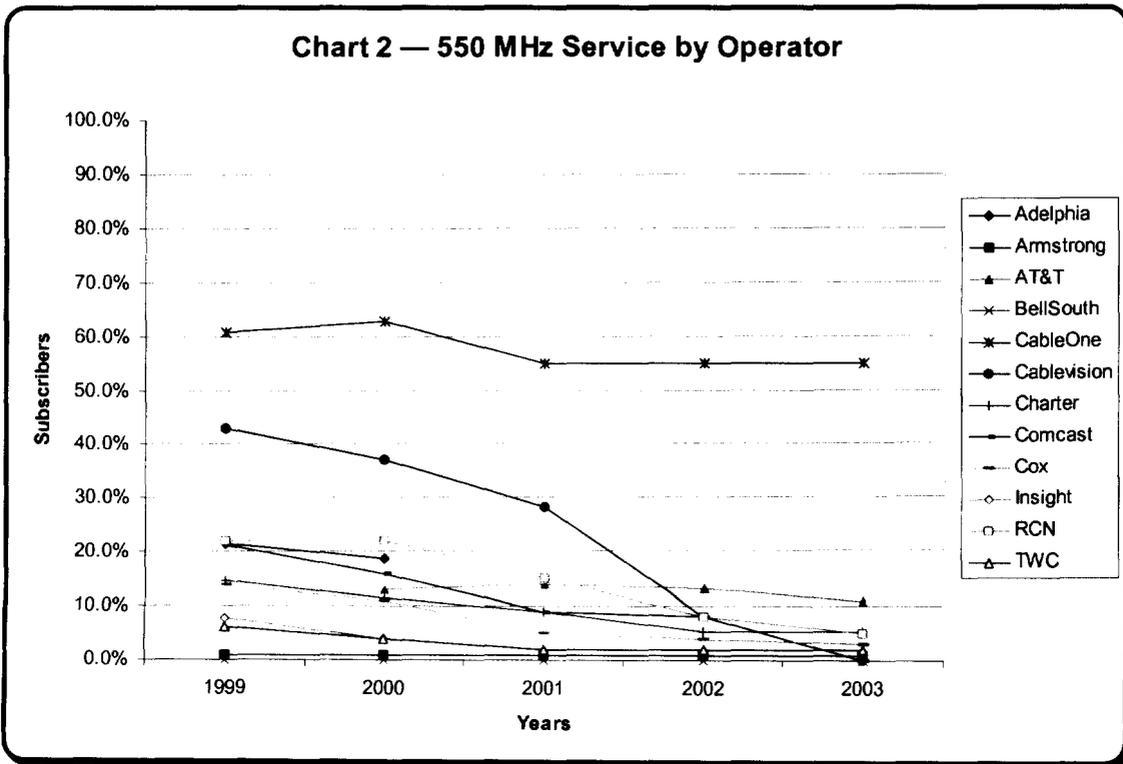
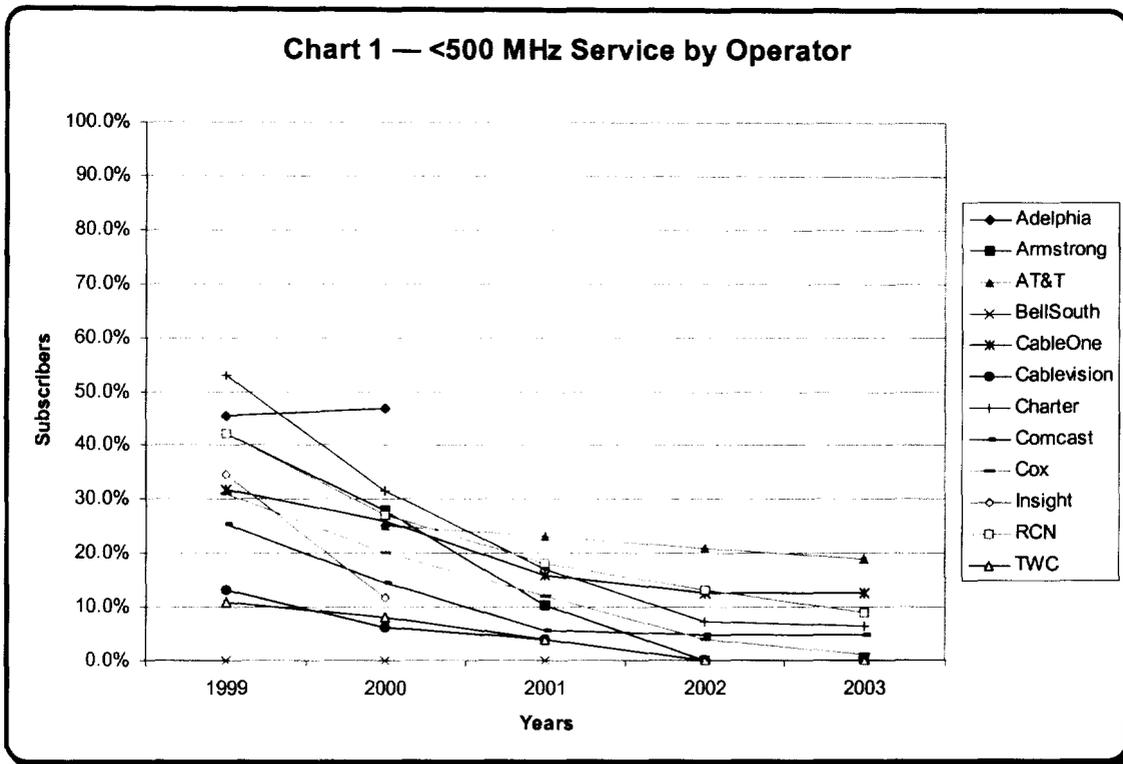
As did most of the questions, Question 1 sought information in snapshots at yearend for the five years 1999 through 2003. It asked about the number of subscribers served in prior years or estimated to be served in future years by systems having bandwidths under 500 MHz,² of 550 MHz, between 550 and 750 MHz, of 750 MHz, and greater than 750 MHz. A table was provided for submission of the requested information.

The responses from the twelve system operators returning the survey are summarized in five charts. The first four, Charts 1 through 4, respectively, show the individual responses of the organizations with respect to the percentages of their subscribers receiving less than 500 MHz service, 550 MHz service, 750 MHz service, and greater than 750 MHz service at the five yearend points. In several cases, the lines indicating a particular operator’s responses do not extend to one end or the other of the charts; this is indicative of data not having been supplied for the years having no values shown.

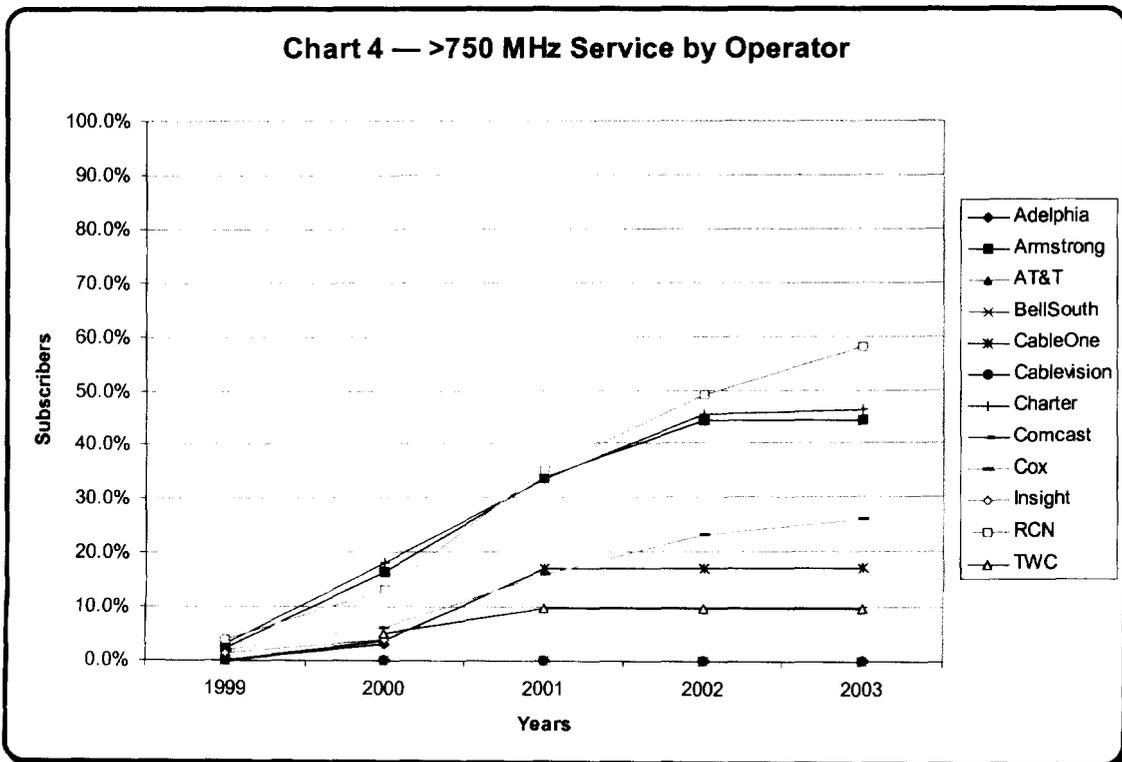
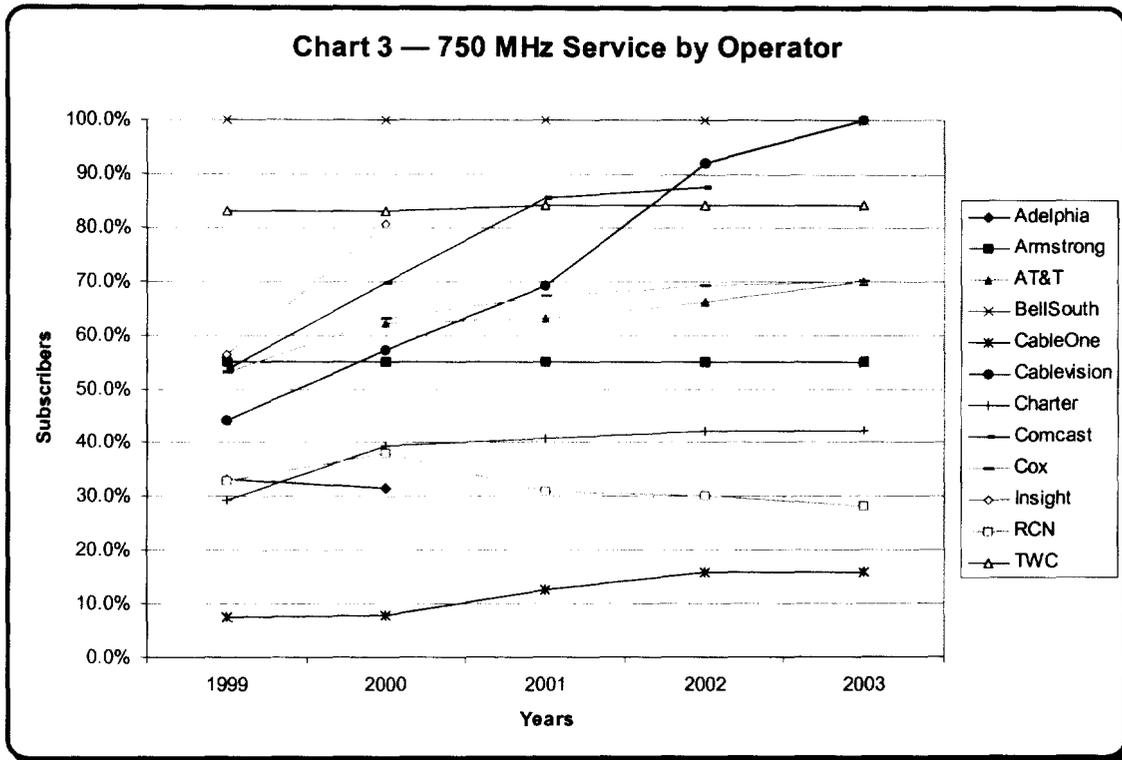
Although the Commission’s survey included five bandwidth categories, only four are reported herein. This results from the fact that only very small percentages (0.8 percent or less for Charter and 3 percent or less for RCN, which redacted all of its subscriber counts) were reported in the category between 550 and 750 MHz. We have consequently included the values for that interval with the results for 550 MHz since there is such a small subscriber base receiving such service that it has no statistical significance. (Comcast chose this method of reporting as well, combining the data for the two categories.)

² The FCC survey form used a bottom category of “Under 500 MHz” for Question 1 while the next lowest category in that question was 550 MHz. That leaves a gap of 50 MHz between categories. All but one of the cable operators answered the question as written – that one changing the category to less than 550 MHz. Since there are no practical systems having a bandwidth between the two values, the gap has no real effect upon the validity of the data collected. The remaining questions with such bandwidth categories used less than 550 MHz for the bottom category. The data are reported herein as requested by the survey.

Analysis of Cable Operator Responses to FCC Survey of Cable MSOs



Analysis of Cable Operator Responses to FCC Survey of Cable MSOs



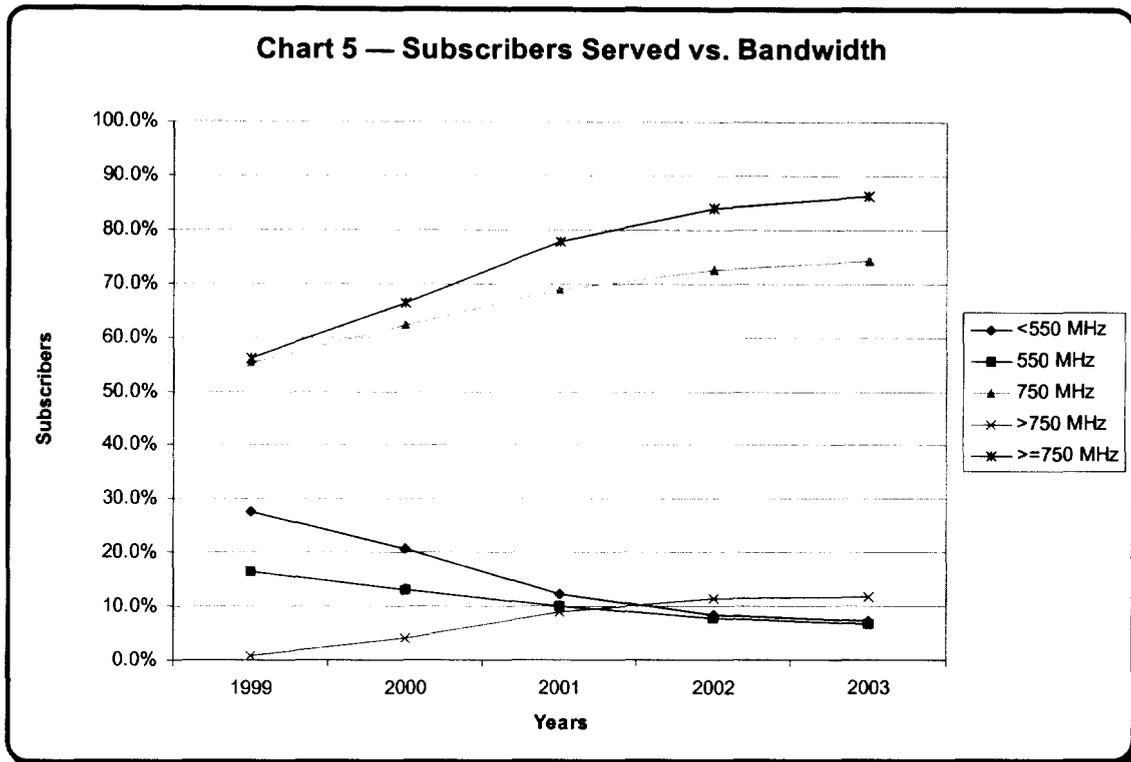
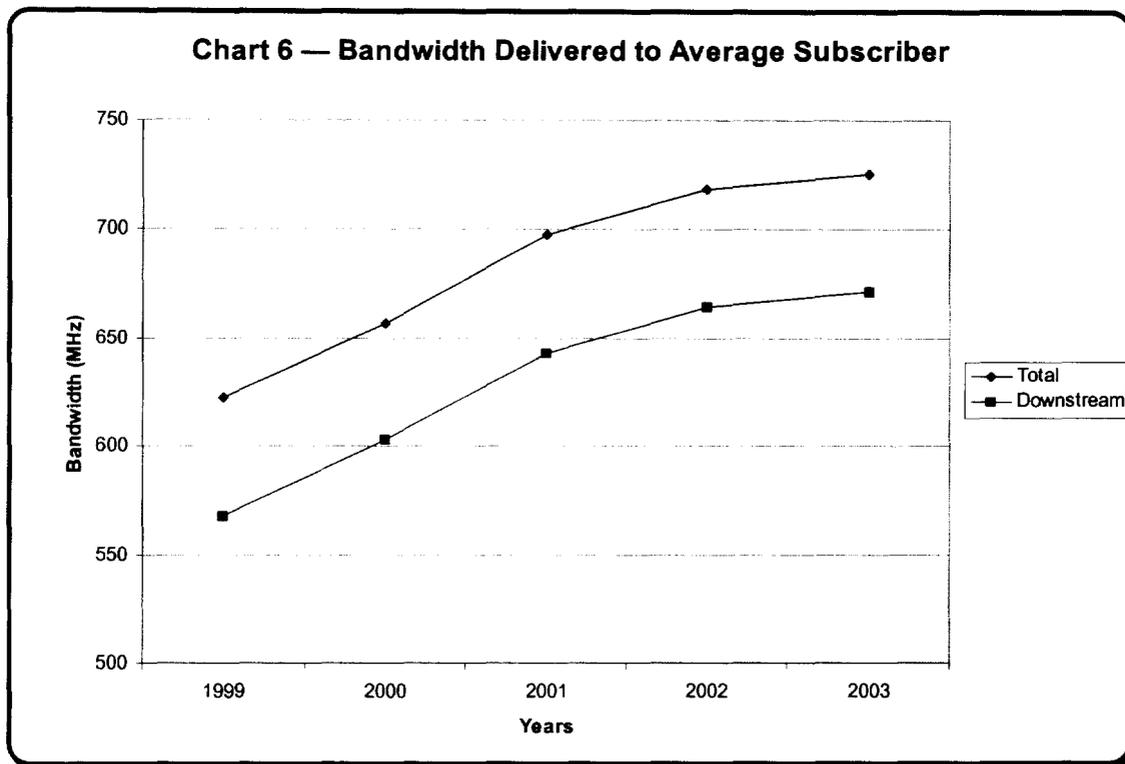


Chart 5 shows the percentage of subscribers served by each bandwidth of service. There are separate lines for each of the four categories included in this report. In addition, a fifth line is included showing the total percentage of subscribers receiving service with a bandwidth equal to or greater than 750 MHz. This allows easy recognition of those receiving at least the 750 MHz level of service.

There are a number of very clear trends revealed in the data by the charts. Looking first at Charts 1 and 2, it is clear that systems having bandwidths of less than 750 MHz are dramatically declining in number and in the percentage of their subscribers served. Charts 3 and 4 show that systems having bandwidths of 750 MHz or greater are substantially increasing in number and proportion of subscribers served, with some operators achieving 100 percent of their systems in this range during the period covered by the survey. Chart 5 shows that, when the various system upgrades are evaluated using the numbers of subscribers they serve as a weighting factor, there are clear national trends to deliver increased bandwidth to subscribers.

Summarizing Chart 5, the proportion of subscribers being served by the two lower frequency categories, viz., <500 MHz and 550 MHz, are dropping during the period covered from 27.5% and 16.3%, respectively, at the end of 1999 to 7.3% and 6.7% at the end of 2003. At the same time, the proportion of subscribers being served by the two higher frequency categories, i.e., 750 MHz and >750 MHz, are increasing during the period covered from 55.2% and 0.9%, respectively, at the end of 1999 to 74.2% and 11.8% at the end of 2003. Another way of looking at this is shown in the uppermost line in Chart 5, which portrays the total of 750 MHz and >750 MHz (essentially 860 or 870 MHz service) increasing from 56.1% at the beginning to 86.0% at the end of the period.



Yet another way to look at the growth in the capacity of the cable industry is to consider the bandwidth delivered to the average subscriber. This can be found by weighting the bandwidth of each category by the proportion of subscribers receiving service in that category in any given year. The result of this calculation is shown on the upper line in Chart 6. There it can be seen that the bandwidth delivered to the average viewer, according to the cable operators' data, increases over the period from 1999 through 2003 from 621.95 MHz to 725.2 MHz – an increase of 103.25 MHz, or somewhat over 17 channels of 6 MHz each.

Some explanations of the methods used to arrive at the various values shown in the several charts are required. A variety of steps were sometimes necessary to make the data consistent from one operator to another and to make it relevant to the question. The need for this treatment results from the fact that some operators did not provide the data requested but instead substituted other, somewhat related data they had at hand. In other instances, only partial data was supplied, and it has been necessary to extend some data provided or to fill in certain details in order to make what was supplied relevant to the question. The handling of each operator's data is discussed in Annex A — Treatment of Cable Operators' Data.

Question 2 — Downstream Bandwidth Utilization vs. Time

Once the overall bandwidth of systems is known, the next step in determining the real capacity is to examine the utility of the different parts of the spectrum for various applications. This information was sought by Question 2 along with system operator expectations about the bandwidths that they would utilize for several coarsely defined

Analysis of Cable Operator Responses to FCC Survey of Cable MSOs

applications. Thus Question 2 asked about the total bandwidth usable for downstream transmissions in each of the bandwidth categories in each of the years covered by the survey for representative systems (the largest of each operator in the particular bandwidth category). It then asked for a breakdown of that total bandwidth into those portions expected to be used for analog video, digital video, and other downstream services. It asked for responses in MHz and provided a table for each of the five years covered by the survey.

Respondents to the survey fell into two categories regarding their answers about the total bandwidth ("total MHz" in the terms used in the survey) usable for downstream transmissions. Most indicated a bandwidth 54 MHz less than the total capacity of the representative cable system in each category. This was the expected value and is the industry norm, essentially allocating the spectrum below television Channel 2 to upstream transmissions. A few respondents supplied a value 50 MHz less than the total system bandwidth; these were treated the same as those who reserved 54 MHz for upstream signals in the belief that they were fundamentally rounding their answers.

The second category of respondents to the question about total bandwidth usable for downstream transmissions indicated a bandwidth 74 or 78 MHz less than the total system capacity. The survey had requested explanation of "any discrepancies between capacity usable for downstream transmissions and total capacity minus the bandwidth below 54 MHz." In some cases, the difference was explained as accounting for the FM band and the 4 MHz gap between Channels 4 and 5. One respondent also subtracted 2 MHz for the gap between Channels 6 and cable A-5. In the other cases, the difference from 54 MHz was not explained. There was no year-to-year variation in any of these numbers.

The First Report and Order in CS Docket 98-120, released January 23, 2001, reaffirms at Paragraph 41 that the number of "usable activated channels" on a cable system is to be determined according to Section 76.5(oo) "as those activated channels of a cable system, except those channels whose use for the distribution of broadcast signals would conflict with technical and safety regulations." Section 76.5(oo), in turn, points to Part 76, Subpart K, for further information on technical and safety regulations. Part 76, Subpart K (§76.601 through §76.630) puts no limitation on the use of the FM band (88-108 MHz) or the spectrum segments between Channels 4 and 5 and Channels 6 and A-5. The First Report and Order also explains in Paragraph 41 how to convert usable activated channels to bandwidth in MHz so as then to apply the one-third cap on required broadcast signal carriage.

Given the instructions in the First Report and Order and the language of 76.5(oo) and Part 76, Subpart K, it is clear that the respondents who indicated a total bandwidth usable for downstream transmissions over 54 MHz less than the system capacity did not appreciate the impact of that decision or of the Rules on their answers. Consequently, in treating the downstream system bandwidth in the discussion below, it will be considered that all systems have 54 MHz unusable for downstream transmissions by virtue of its being allocated to upstream transmissions. No other subtractions will be made from overall system capacity as no respondent offered any indication of spectrum utilization limitations caused by adherence to "technical and safety regulations."

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The remainder of the table in Question 2 sought data on historical and expected future uses of the downstream bandwidth for analog video, digital video, and other downstream services. From the standpoint of determining the channel capacity that will be available for carriage of broadcast signals, these distinctions are immaterial. This results from the First Report and Order's instructions, in Paragraph 40, that the calculation of bandwidth derived from the usable activated channels "includes but is not limited to the cable spectrum used for internet service, pay-per-view and video-on-demand, and telephony." Those are the sorts of uses enumerated in the columns for digital video and other downstream services. They are to be aggregated with the bandwidth for analog and other digital video services. So for the purposes of this analysis, there is no need to treat them separately.

We thus arrive at the total bandwidths usable for downstream transmissions associated with the several system capacities. They all are found by subtracting 54 MHz from the total system capacity, as shown in the following Table 1 for a number of system capacities.

Table 1 — Usable Downstream Bandwidth vs. Total System Capacity

Capacity of Cable System	Total MHz Usable for Downstream Transmissions
860 MHz	806
750 MHz	696
610 MHz	556
550 MHz	496
450 MHz	396
330 MHz	276

The same factors can be applied to the bandwidth delivered to the average subscriber, as was shown on the upper line in Chart 6. If the same 54 MHz is subtracted from the values on that line, the result is a bandwidth usable for downstream transmissions to the average subscriber of 567.95 MHz at yearend 1999 rising to 671.2 MHz at yearend 2003 — again yielding an increase of 103.25 MHz. This is shown on the lower line in Chart 6.

Question 3 — Digital Modulation Techniques & Channel Loading

Once the bandwidth available for downstream transmissions is known, the next step in understanding the industry capacity is to determine what modulation techniques are available and what can be done with them. Question 3 of the survey addresses these system features by asking for data on the total bandwidth expected to be used for digital

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transmission (as listed in response to Question 2), the modulation technique to be used, and the bandwidth to be devoted to each of several coarse application areas.

The cable industry has adopted Quadrature Amplitude Modulation (QAM) as its modulation standard. There are two principal variants of QAM in use: 64-QAM and 256-QAM. The associated value indicates the number of distinct points in the modulation constellation that each transmitted symbol could adopt. The data are randomized and other techniques are applied so that each constellation point has equal probability of occurrence. The two descriptive values are both powers of 2 and indirectly indicate the number of bits that each transmitted symbol carries. 64, which is 2^6 , carries 6 bits per symbol. 256 is 2^8 and carries 8 bits per symbol.

The number of symbols that can be transmitted per second is determined by the bandwidth used and certain filter characteristics. In a 6 MHz channel, somewhat over 5 Mega-symbols per second (Msps) can be transmitted with practical filters used. When the number of symbols per second is multiplied by the number of bits per symbol, the result is about 27 Megabits per second (Mbps) for 64-QAM and about 38 Mbps for 256-QAM (both after various forms of error correction overhead).³ Thus the 256-QAM variant can carry about 40 percent more data than can 64-QAM. Because there are four times as many symbol locations in the constellation for 256-QAM, this means that the 256-QAM symbols are much closer together for the same average power level. Hence 256-QAM theoretically requires a 6-dB higher signal-to-noise (S/N) ratio at the receiver (or set top box),⁴ with perhaps another 1-2 dB for implementation losses, in order to produce the 40 percent higher data rate of which it is capable.

The data provided in response to Question 3 show that 64-QAM is universally used and that most of the system operators are also adopting 256-QAM for at least some services in the future. The operators now using or planning future use of 256-QAM are shown vs. system bandwidth and yearend in Table 2 below. In the table, a number designates each operator. That number is entered in each of the cells where that operator has indicated use of 256-QAM by the end of the year in a particular bandwidth system.

Several other factors are just as significant as the number of operators adopting 256-QAM. First is the fact that, with the exception of the very first generation of digital set top boxes, just about every piece of equipment made for digital cable signal reception includes 256-QAM reception capability. This includes all set top boxes sold within the last several years and all cable modems and will include all cable-ready digital television receivers when they become available in the future so long as they conform to the appropriate standards.

³ The "Digital Video Transmission Standard for Cable Television," SCTE DVS-031, of the Society of Cable Telecommunications Engineers specifies the symbol rates and bit rates for 64-QAM and 256-QAM modulation in 6 MHz channels. The precise values are 5.056941 Megasymbols per second (Msps) and 26.97035 Megabits per second (Mbps) for 64-QAM and 5.360537 Msps and 38.81070 Mbps for 256-QAM, respectively.

⁴ Walter Ciciora et al., *Modern Cable Television Technology*. San Francisco: Morgan Kaufmann, 1999, pp. 181-182, 187-189.

Table 2 — Operator Utilization of 256-QAM

BW	1999	2000	2001	2002	2003
>750		5	1,5,12	1,5,7,9,12	1,5,7,9,12
750	1	1,5	1,5,12	1,5,6,7,9,12	1,5,6,7,9,12
550	1	1,5	1,5	5	3,5,7
<550			5	5	3,5
	1. Adelphia 2. Armstrong 3. AT&T	4. BellSouth 5. CableOne 6. Cablevision	7. Charter 8. Comcast 9. Cox	10. Insight 11. RCN 12. Time Warner	

A second significant factor is that there are generally no technical impediments other than adequate signal-to-noise (S/N) ratio to the use of 256-QAM. Inadequate S/N can result from long cascades of amplifiers, as were used in low bandwidth systems built years ago. But the recently reconstructed infrastructure of cable systems delivers signals over fiber optic cables to nodes that then feed small neighborhoods through coaxial cables with, at most, a few amplifiers in cascade. Inadequate S/N can also result when there is too much splitting loss in a particular home, but this is a problem in individual dwelling units and not a system-wide problem. Thus, in essentially all the rebuilt cable infrastructure, which uses a hybrid fiber/coax (HFC) architecture, there are essentially no limitations on 256-QAM utilization.

A third significant factor is the number of services that can be carried on each modulation density. There was general agreement among respondents to the FCC survey that provided data that two digital broadcast signals of 19 Mbps each can be carried on a single 256-QAM-modulated channel. There were also those who noted that up to three satellite-delivered HDTV signals with certain resolution limits could be carried on a single 256-QAM-modulated channel, or two of those same resolution-limited HDTV signals could be carried on a 64-QAM-modulated channel.

Two respondents (Comcast and Cox) both indicated some problems in moving to 256-QAM modulation, but their concerns were based strictly on the investments they already have in 64-QAM-limited set top boxes in service rather than on any technical limitations. This could put limits on their flexibility in converting to 256-QAM any services delivered to subscribers using the older set top boxes. It would not restrict, however, their ability to utilize 256-QAM for services to be delivered to subscribers known to be equipped to receive 256-QAM signals.

Question 4 — Retransmission Consent Agreements Completed & In Negotiation

The Commission sought information on the specific agreements completed by each of the respondents' systems with respect to each digital television broadcast station covered by an agreement and with respect to each agreement currently in negotiation. It further sought detailed information about the network affiliations of the covered stations, the bandwidth capacity of the systems involved, the modulation techniques to be used, the broadcast transmission formats, the retransmission formats, and the numbers of stations in each DMA now transmitting digitally.

Responses varied from a complete list from AT&T of stations and systems covered by agreements to carry the owned and operated stations of NBC and Fox (although without the other data the Commission had sought) to detailed narrative descriptions of agreements in place and plans for future carriage by Cox and Time Warner. A few of the other respondents provided relatively brief comments that described one or perhaps a few agreements in place. The remainder indicated no agreements in place and no negotiations in progress, or they simply did not respond.

With respect to our determination of industry capacity and the potential burden that digital must carry could place on cable systems, the information on retransmission consent agreements in place or in negotiation is immaterial. It is reported here for completeness but will not be considered further.

Cable Industry Bandwidth Capacity

In evaluating the capacity of the cable industry to transmit the broadcast signals that it would be obligated to carry in a digital must carry regime, a number of factors must be considered. Many of them have already been explored; they will be summarized here to make apparent their impact on industry capacity. A few other items must be considered for the first time.

The capacity of the cable industry can be summarized as the total bandwidth available to the average subscriber minus the bandwidth used for upstream transmissions and any limitations in use for meeting technical or safety regulations. Operationally, the resulting downstream bandwidth is split between analog and digital services in cable systems, but the FCC has held⁵ that the maximum proportion of capacity to be allocated to commercial broadcast signals is to be calculated using pure bandwidth, measured in MHz. The fraction of the available bandwidth is to be determined without subtractions from capacity for other applications such as telephony and Internet access.

In order to determine the "burden" that would be placed on a cable system by broadcast signals of different types, it is necessary to consider the type of modulation that would be used and the capacity of that modulation to carry signals of various types. The amount of spectrum needed to carry the signals can then be divided into the available downstream bandwidth allocable to broadcast carriage to determine the number of broadcast stations

⁵ First Report and Order and Further Notice of Proposed Rulemaking In the Matter of: Carriage of Digital Television Broadcast Signals, CS Docket 98-120, at Paragraph 40.