Table 3 Unweighted Average Channel Capacity and Unused Channels by Ownership Rank			
	Unweighted Average		
Ownership Rank	Channel Capacity	Unused Channels	Number of Systems
1-5	45.51	6.89	1,493
6-10	46.65	5.77	438
11-25	39.64	6.36	1,605
26-50	40.34	6.86	1,197

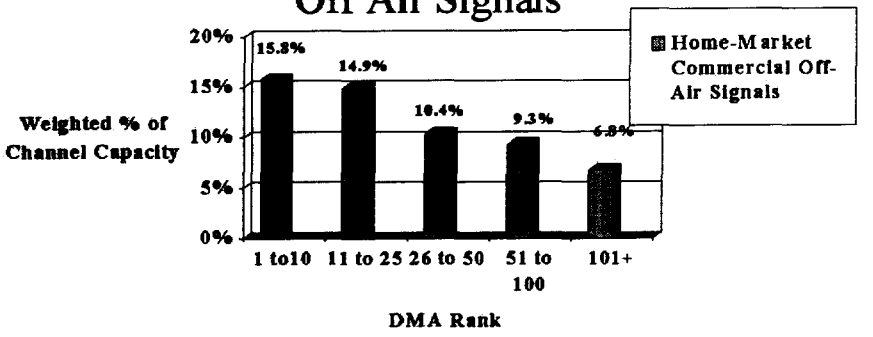
C. Off-Air Signals on Cable Systems

Given these channel capacities, we next examine what portion of cable systems are currently allocated to carriage of commercial off-air signals. While some of these signals are carried subject to the current must-carry rules, many, if not most, are carried voluntarily under retransmission consent agreements. Thus, the percentages represented overstate the "burden" of must-carry today.

Nationally, the weighted average percentage of cable-system channels occupied by home-market commercial off-air signals[34] is 12.2 percent. The unweighted national average is 11.1 percent. Figure 6 shows the weighted average for home-market commercial off-air signals for the five market-size groupings. Not surprisingly, as one moves to smaller markets, fewer of the cable systems' channels are allocated to home-market off-air signals since there are fewer over-the-air television stations in those markets.

[34] "Home-market commercial off-air signals" refer to those over-the-air full-power commercial television stations that are located in the same television market as the cable system.

Figure 6
Percentage of Channel Capacity
Allocated to Home-Market Commercial
Off Air Signals



*Weighted by number of subscribers within each group

Prepared By Research & Planning Department, National Association of Broadcasters

Table 4 shows the unweighted averages of cable capacity allocated to home-market commercial off-air signals for the five market-size groupings. Like the weighted averages, the unweighted averages for home market off-air signals decrease as one moves to smaller markets.

Table 4
Unweighted Average Percentage of Channel Capacity Allocated to Home-Market Commercial Off-Air Signals by DMA Rank

DMA Rank	Percentage
1-10	16.3%
11-25	13.4%
26-50	12.6%
51-100	11.1%
101+	8.4%

Our analysis of the current cable system capacity occupied by home-market commercial off-air signals produces several interesting observations. First, the average capacity currently occupied by such signals is today well below the 33 percent of capacity limit established by statute for must-carry. Second, even if the existing percentages doubled (as each station adds its DTV signal) and

cable capacity stayed the same, the total capacity occupied by home-market commercial off-air signals would be, on average, below the statutory ceiling. Third, cable systems in smaller markets (where there are also fewer broadcast stations) have relatively more unused capacity. This fact strengthens the case for an across-the-board must-carry rule applicable to all cable systems.

D. Synopsis

Our analysis of cable system channel capacity indicates that: (1) channel capacity has been expanding significantly over time; (2) existing channel capacity is quite substantial, particularly in large markets where the Commission has required digital television service to be rolled out first; (3) significant unutilized channel capacity currently exists; and (4) the capacity occupied by local broadcast stations (those eligible for must-carry) is well below the 33 percent statutory ceiling. These data provide *conservative* measures on a variety of counts (*viz.*, they are historical data, capacity is being expanded, technical advances are constantly increasing the carrying capacity of given bandwidth, *etc.*). They suggest that there are no *technical* constraints limiting the carriage of digital broadcast signals as the digital transition commences. Existing unused capacity in most cases could easily support carriage of new digital broadcast signals when the initial stations begin operation later this year.

VI. Cable Capacity in the New Digital World

A. Introduction

In this section of our report, we discuss the impact of current changes in video distribution technology on the major questions identified in the *Notice*, including the definition of cable capacity in the new digital world. Specifically, we review the impact of technological changes on the capacity of cable systems in the future, including the ability to increase the bandwidth of coaxial cable systems, the introduction of fiber optics into terrestrial video distribution systems, improvements in video encoding and compression technology, and the role of digital set-top boxes. We also discuss the implications of likely future uses of cable systems for non-TV telecommunications applications such as cable modems for Internet access, two-way interactive video, and voicegrade telephony. Our analysis shows that cable systems will be expanding capacity substantially over the course of the next five years during which time the transition to digital television is expected to take place.

B. Expansion of Cable Capacity for Video Distribution

Coaxial cable systems were first deployed in the 1960s to bring television programs to areas where broadcast signals were weak or nonexistent. The systems were technologically uncomplicated, consisting of a "head-end" where television signals were received over the air and a coaxial cable distribution system which retransmitted those signals past the homes of potential subscribers. Six MHZ of frequency spectrum was assigned for each over-the-air broadcast channel. These signals were remodulated and retransmitted, intact, over the coaxial cable systems. Since the signal became attenuated as it passed through the cable, amplifiers were installed at specified intervals to maintain the signal at appropriate levels. If a particular customer wanted to subscribe, the coaxial cable was "tapped" and a piece of cable installed to connect the main cable to the home.

Although the basic elements of coaxial cable systems have remained unchanged during the past 30 years, the use, extent, capacity and capability of cable systems have changed enormously. Coaxial cable systems are now deployed widely throughout the country, and provide many services in addition to those that originate over the air. Indeed the majority of television viewers in the United States today rely on cable as the primary means of obtaining television signals.

Among the most significant changes which have taken place in cable technology over the decades has been the continuous increase in the number of 6 MHZ television channels that can be carried on a coaxial cable (as discussed in the previous section). This is determined by the

bandwidth of the system, which in turn is a function principally of the capabilities of the amplifiers and the number of amplifiers in the series that must be traversed to reach the farthest customer.

As the bandwidth of the system increases, the spacing of the amplifiers must be decreased, since attenuation rates increase with increasing frequency. Furthermore, since whatever noise is introduced into the signal as it moves through the cable is amplified along with the signal, noise accumulates as the number of amplifiers increases. In order to prevent unacceptable deterioration of the signal, at some point, fiber optics can be introduced to replace the coaxial trunk plant, or backbone. Fiber optic systems usually do not employ amplifiers, and each remote node or coaxial cable section is served by one fiber. Fiber optic systems have virtually limitless bandwidth so, once in place, they can continue to support increases in capacity as the coaxial cable sections are upgraded. For this reason, they have proven to be an economical choice in many areas, and continue to be deployed at a rapid rate.[35]

The frequencies used in cable TV systems start at about 55 MHZ, which is Channel 2. Frequencies between 88 MHZ and 108 MHZ, which is the FM spectrum, and between 108 and 120 MHZ, which is allocated to aircraft communication and navigation, are usually not used because of the potential of interference with these services. Frequencies below 55 MHZ are reserved for potential traffic originating at the customer location and terminating at the head-end. Therefore, the effective analog capacity of the system is determined primarily by the upper bound of the amplifier capability. A 300 MHZ system can support about 36 channels, 400 MHZ about 52 channels, 550 MHZ about 77 channels, 750 MHZ about 110 channels and 1 GHz about 150 channels. Currently, there are a large number of 750 MHZ systems in place with a few at 1 GHz. Industry forecasts indicate that the number of these high capacity systems will substantially increase in the next few years.[36]

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[35] Cable companies accelerated their deployment of fiber optics in 1997 by 27 percent over 1996, totaling 134,370 route miles; cable operators are projected to deploy 23 percent more fiber in 1998, totaling 164,750 route miles. *See* National Cable Television Association Website at <http://www.ncta.com/overview98_1.html>, September 14, 1998.

[36] The National Cable Television Association (NCTA) claims that there will be $33 billion in infrastructure improvements during the years 1996-2001 and that 71 percent of cable homes would be passed by 550 MHZ-750 MHZ plant by yearend 1998. (*Ibid.*) NCTA has stated that "(c)able companies will invest (sic) over $12 billion over the past two years alone to upgrade their systems to provide customers with the best digital television." *See* Letter to Edward O. Fritts from Decker Austrom, President and CEO, NCTA (October 6, 1998). Time Warner recently announced that its $4 billion project to upgrade cable systems to a 750 MHZ, two-way plant had been accelerated and was on track for early completion in yearend 2000. (Testimony of Joseph J. Collins, Chairman and

(continued...)

The above discussion relates to the number of traditional 6 MHZ wide channels that can be carried on a cable TV system. As noted, this has been increasing steadily almost since the beginning of cable TV, and is expected to continue to increase for the foreseeable future.[37] An even more significant development, however, is the introduction of digital encoding and compression into the world of video transmission and distribution.

Digital encoding involves transforming the analog signal associated with a television signal into a stream of digital pulses, or bits — essentially a sequence of ones and zeros that completely represent the original signal. Digital encoding has many desirable properties. First of all, when a digital signal is sent down a transmission line such as a coaxial cable, it, too may need to be amplified periodically. However, the "amplifiers" in this situation merely regenerate the ones and zeros they receive so that, unless the signal is so badly deteriorated that the ones and zeros are unrecognizable, the signal leaving the amplifier is the same as the signal that entered the system. There is no accumulation of noise, which allows higher quality reception in most cases. Even in the event that there are errors in some bits, error-correcting codes are used to eliminate them.

For video distribution, these digital pulses are modulated into a radio frequency analog signal, and sent on the same 6 MHZ channels used for analog signals. Current coding methods allow up to 38 MB/s of digital information to be sent on a single 6 MHZ channel through a cable system. (Over-the-air broadcasts can transmit at only half that rate, because the signals are subject to interference from other signals, fading and multipath interference — obstacles that are in large measure not present within the closed environment of a cable TV system.)

Secondly, and perhaps more importantly from the standpoint of television distribution, the fact that the signal is now a series of binary digits allows the signal to be compressed to remove any

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36 (...continued)
CEO Time Warner Cable before the Senate Commerce Committee, July 8, 1998). TCI recently announced it was way ahead of schedule on upgrading its cable infrastructure that will give it two-way capability on more than 90 percent of its network by the end of the year 2000 and that between 92 and 95 percent of TCI's network will be able to handle two-way data and voice transmission. By yearend 2000, all TCI metropolitan areas are scheduled to have 750 MHZ plant and the suburbs at least 550 MHZ. (Grant Buckler, "AT&T & TCI Say Cable Upgrades Well Under Way," *Newsbytes*,June 29, 1998). Comcast estimated that, by yearend 1998, approximately 80 percent of its physical plant would be upgraded, with a majority of its cable systems providing 750-MHZ capacity. (Comcast Summary Annual Report 1997).

37 Paul Kagan Associates, Inc., has modeled cable channel capacity through the year 2004. Starting with a base of an average weighted 53 channels in 1996, Kagan predicted that channels would increase from 75 in 1998 to 140 in 2003 (interpolating the estimates for 2002 and 2004) — an increase of 65 channels. *See* Paul Kagan Associates, Inc., "Channel Logjam Eases — Capacity Projections to 2004," *Cable TV Programming*, July 31, 1996.

information which may be redundant or irrelevant. Successive frames of a television signal often contain much information that is unchanged. Digital signal processing can detect this, and transmit a very brief indicator that the item is unchanged, sharply reducing the number of bits required to convey the signal to the end user.[38] Several industry standards — denoted MPEG-1 and MPEG-2 — have been adopted for digital compression, with the result that many television signals can be carried in a single 6 MHZ analog channel.

The MPEG-1 standard will allow a single television signal to be compressed to as little as 1.5 MB/s while apparently retaining VHS videocassette quality. Full NTSC quality requires about 4 MB/s. Moreover, if a number of digital signals are sent over the same 6 MHZ channel, "statistical multiplexing" can be used. In this arrangement, the carrying capacity of the channel can be statistically shared between signals. Thus if, at a given point in time, one signal contains a lot of motion, which requires more bits, it can "steal" bits from a signal which is not currently experiencing any change between frames. This allows even more signals to be carried in a single 6 MHZ channel. The benefit of this approach has not been fully quantified, but one manufacturer has announced a system with 24 signals per channel,[39] and TCI's "Headend in the Sky" (HITS) system accommodates 18 digitized television signals in a single 6 MHZ channel.

MPEG-2 is used for the digital television (DTV) broadcast standard. It allows an HDTV signal to be compressed into about 19 MB/s of digital information, which, as discussed above, can be carried on a single 6 MHZ over-the-air channel or as half of the multiplex on a 6 MHZ cable channel (when digital modulation is used). The standardized 19 MB/s bit stream can also be used by broadcasters to provide a number of NTSC-quality programs or other signals.

Another aspect of the coming transformation of the industry is that, since digital technology relies heavily on technology commonly used in the computer and communications industries, most notably digital integrated circuit chips, costs can be expected to decline rapidly in the foreseeable future. "Moore's Law" formulated by Gordon Moore, a founder of Intel, states that the cost of semi-

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[38] Using digital compression technology, operators are compressing as many as 12 digital channels into the space used by one analog channel, but are experimenting with compression schemes that exceed 20-to-1. (SG Cowen Securities Corporation, "Cable Television Industry Report", July 9, 1998, p.22. In 1997, TCI reported several important digital technical developments, including advancing its digital compression ratio to up to 12-to-1. (1997 TCI Annual Report). Industry analysts have anticipated that new digital services will use only small amounts of bandwidth, allowing capacity for future services. Salmon Smith Barney, "Entertainment/Media/Communications — Industry Report", J.S. Krutick, et. al, February 2, 1998.

[39] *See* IMEDIA brochure: *IMEDIAStatMux, 24 Digital Channels in the Space of a Single Analog Channel.*

conductor devices drops by half every 18-24 months. This has been true for decades, and is expected to continue well into the next century

Taking all these factors into consideration, we see that the potential capacity of cable systems is likely to grow explosively within the next few years.[40]

Summarizing the above, the total system capacity of a cable TV distribution system is a function of:

- The total number of 6 MHZ channels (750 MHZ ≈ 110 channels);
- The number of channels converted to digital transmission;
- The transmission system used, which determines the digital data rate per 6 MHZ channel (current maximum of about 38 MB/s), and
- The compression method used and the signal quality desired (HDTV, SDTV, *etc.*), which determines the number of digital programs sent over a 6 MHZ channel (current maximum of 24, assuming 38 MB/s and extensive use of statistical multiplexing)

In a conservative example, if an 80-channel system devoted 4 channels to digital, ran the digital channels at 38 MB/s, and ran 18 multiplexed video signals per channel, then the total system capacity would be 76 plus 4 times 18, or 148 program services. In such a system, even if an additional 20 digital broadcast television channels needed to be carried, these would fit into ten 6 MHZ channels, or 6.8 percent of the system capacity.

If a cable operator in a smaller market had only 50 channels of capacity and did not operate a digital service, the broadcast digital signals would presumably be "passed through." Thus, if there were ten digital broadcast channels in the market, ten 6 MHZ channels, or 20 percent of system capacity, would be needed to carry them.

At the upper extreme limit (and no one has as yet proposed doing this), if a cable system with 110 6 MHZ channels operated its entire system digitally with even as few as 8 signals per channel,

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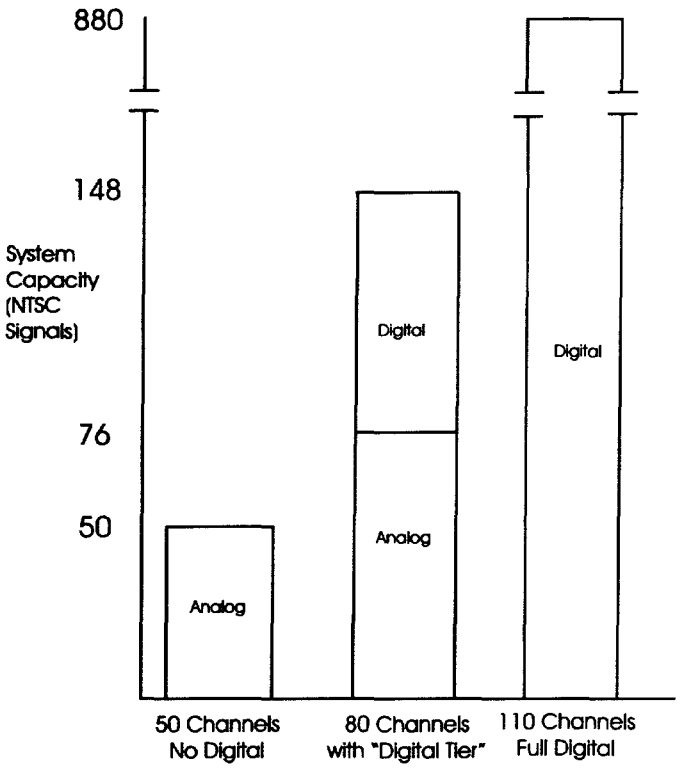
[40] Earlier this year, TCI expected to have between 800,000 and 1 million digital cable customers by yearend, and claimed to be rolling out digital as widely and quickly as possible. In March of this year, TCI was reportedly installing digital at the rate of 1,700 per day and expected to increase to 3,000 and 4,000 installations per day in the following month. ("More on TCI Digital" *Media Daily*, March 26, 1998). It is reported that most industry estimates say digital will replace advanced analog within seven to 10 years. As of May, TCI digital cable was reported to be available to more than 11 million of its 14 million subscribers, Time Warner was preparing to launch 79 channels of digital on top of 75-80 channels of analog, Cox intended to offer digital in all nine of its major cluster markets, which encompass roughly 85 percent of its total subscriber base. (*Broadcasting & Cable*, "Special Report '98" May 4, 1998). According to the Cox Communications/New England web page, Cox's rebuild will result in "100's of new cable channels." *See* http://www.cox.win/newengland/genifo/ge02001.htm.

it would yield a system capacity of 880 video signals. Again, 20 digital broadcast video signals using ten 6 MHZ channels would effectively displace 80 of the 880 channels, or 9 percent.

The range of potential system capacity is illustrated by the scenarios in Figure 7.

With all these possibilities, and with widely varying rates of capacity expansion among operators, it is extremely difficult to predict a precise measure of system capacity at any particular point in time during the next five years. On the one hand, a case could be made for assuming that

Figure 7
Cable System Scenarios



the maximum attainable capacity will be achieved, since all operators have the potential for reaching the maximum. On the other hand, since many operators will not, in fact, exploit the full potential, it can be argued that some other assumption should be used. It seems, however, that some number between the current deployment and the maximum possible is reasonable to assume. Certainly, given the technological opportunities discussed above, and the potential additional service opportunities discussed below, a number between 200 and 500 mixed digital and analog channels is readily within the reach of most operators within the next few years, and is a reasonable number to use to estimate the "burden" of full digital TV must-carry.

C. Set-top Boxes

Not only must digital signals be properly processed at the head-end (although the HITS system does that for the operators) but, more importantly, they require digital set-top boxes in every home that receives the digital signals. The current strategy of the cable operators is to roll out digital signals in a "digital tier" which is sold as a premium service, modulating the roll-out of the service and the installation of set-top boxes as the demand for the digital tier evolves.

Set-top boxes have been a staple of the cable TV industry since its beginning. In the analog world, basic set-top boxes are fairly simple devices, which take the analog signal from the cable and remodulate it so that it can be accepted by the television set. Over time, the functionality has increased somewhat, to include signal scrambling in order to prevent unauthorized viewing, and to contain screen menus. Increasingly, many of these functions have been included in "cable-ready" television sets.

The digital world is more complex. Digital set-top boxes accept digital signals, and transform them into analog signals before presenting them to an ordinary analog television set. There is currently no effective industry standard for the functionality of such devices, although standardization efforts are continuing.[41]

It is clearly desirable for cable TV operators to utilize a box which could process its own digital tier, and also a DTV signal from a broadcaster. If cable TV operators are required to carry DTV signals, it is most likely that those who also operate a "digital tier" will specify a set-top box that can process both kinds of signals. This will not add much to the cost of the box, but will allow the cable TV operator to carry two broadcast DTV signals in a single 6 MHZ channel. The alternative is to pass the broadcast signal directly through to the digital TV set, requiring a full 6 MHZ channel to carry a single DTV signal.

Thus, a requirement that cable TV operators carry broadcast DTV signals is likely to spur the effort to reach an industry standard for digital set-top boxes, which in turn would lead to the development of standard, lower cost (because of standard design and increased volume) boxes that

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[41] The National Cable Television Association reports that cable operators continue to develop open technical standards that will accelerate cable's provision of new digital services. In September 1997, CableLabs and its members established "OpenCable," a project aimed at obtaining a new generation of set-top boxes that are interoperable. These new devices will enable a new range of interactive services to be provided to cable customers. Since that time, CableLabs has been establishing consensus within the industry on the appropriate standards, interfaces and features which will allow for this desired interoperability. *See* National Cable Television Association Website at ,http://www.ncta.com/overview98_1.html>, September 14, 1998.

can process a variety of signals which can be fed to both digital and analog television sets.[42] The availability of such units may even provide incentives for cable TV operators to introduce a digital tier if they have not already done so, thus providing their customers with more program choices.

D. Expansion of Cable System Capacity for Telecommunications Applications

As we move into the next century, it becomes increasingly likely that the coaxial cable systems that currently pass nearly all households will be used for a wide variety of telecommunications services. The potential to provide these services is one of the most exciting opportunities faced by the cable television industry. It is this potential that, we believe, will drive the rapid expansion of cable system capacity such that the imposition of full digital television must-carry can be expected to have only minimal impact.

There has been much speculation about the use of cable television systems for telecommunications services for many years, but implementation, until this year, has rarely gone beyond trials. There have been a number of reasons, regulatory, technical, operational and financial, for the failure of this market to develop.

To begin with, up until recently, many local jurisdictions would not allow competition in local telecommunications service, which is where the cable television assets would be most useful.

Secondly, there are substantial technical and operational problems involved in conditioning the cable plant to support telecommunications services. Among these are:

- **One-way versus two-way operation.** Cable system amplifiers usually operate in only one direction. Carrying telecommunication signals, which are always two-way, requires modification of all cable amplifiers.
- **Service continuity in the event of power failure.** Cable systems are typically powered from commercial sources, on the grounds that if power is out there is no need for service

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[42] The TCI Group and other cable operators have placed an order for 15 million advanced digital set-top devices in 1997. (1997 TCI Annual Report.) TCI also has reported plans to embed a cable modem in every digital set-top box it sells in the future. (Grant Buckler, "AT&T & TCI Say Cable Upgrades Well Under Way," *Newsbytes*, June 29, 1998.) Time Warner has announced order of one and a half million advanced digital *Pegasus* set-top boxes, which will allow viewers to receive digital television, including DTV. Time Warner planned to start field-testing of *Pegasus* during 1999. (Testimony of Joseph J. Collins, Chairman and CEO Time Warner Cable before the Senate Commerce Committee, July 8, 1998.) AT&T officials have said that subsidy deals with outside vendors cut the cost of digital set-tops to about $175 from more than $300. (*Television Digest*, "AT&T Plans $4.4-Billion Upgrade," July 6, 1998.)

since the television sets are also inoperable. Telephone systems, however, are powered from the telephone central office, which has various emergency backup systems.

- **System architecture.** Cable systems are normally configured as a "tree" with all signals emanating from the headend and going to all users. Telephone systems are configured as "stars" with each pairwise connection individually established.
- **Billing systems.** Cable systems typically bill on a monthly basis for services provided. Telephone systems are more transaction oriented, keeping track of a myriad of individual calls.

Finally, the financial structure of the cable industry, characterized by heavy debt loads, did not readily lend itself to the substantial capital investments in cable retrofits and switching system acquisitions necessary to enter these markets.

A number of forces are now coming together which promise to overcome these difficulties. The first of these is the passage of the Telecommunications Act of 1996. This landmark legislation established the clear intent to spur competition in local telecommunications markets through the elimination of remaining barriers to entry. Secondly, the explosion of Internet usage, and the increasing demand for higher bandwidth access provides an unprecedented opportunity for cable systems. Cable begins with a decided competitive advantage over the telephone companies since cable has a broadband medium in place. Thirdly, the consolidation of the industry, typified by the pending acquisition of TCI by AT&T will bring both needed capital and telecommunications skills into the cable industry, setting the stage for rapid expansion into telecommunications markets.

The prospect of entering these markets will provide additional incentives for cable operators to continue to expand their systems, both by increasing analog capacity, and by adding digital capabilities, which can clear capacity for telecommunications applications without compromising their basic cable TV business (including the carriage of digital television signals).

To be specific, the telecommunications applications of cable TV are of three basic types — Internet access, or cable modems; voicegrade telecommunications; and two-way video services, including video telephony and video conferencing. We address each of these separately:

1. Internet Access

The virtual explosion of Internet usage during the past few years has led to an accelerating demand for higher data rate access as people try to download video clips, pictures, and ever larger files. The idea of using the coaxial cables that carry TV signals past so many houses for Internet

access has seemed quite evident, since the bandwidth of these cables is so much larger than that of the typical telephone lines. Hence the development of "cable modems," which are currently being deployed in many areas, and for which very rapid growth in the next few years appears almost certain.[43]

Cable modems generally operate at rates of between 4 and 30 MB/s "downstream" from the Internet Service Provider (ISP) to the user, and at a lesser rate "upstream,"[44] compared with a maximum of about 56 KB/s for current modems that operate on telephone lines. This increase of at least several orders of magnitude represents a significant improvement, making some Internet applications feasible that were previously too slow. One of the difficulties in exploiting this demand is that, as mentioned above, cable TV systems are designed for one-way operation. Internet access requires two-way operation, even though the data rates are not equal in both directions. Hence, cable amplifiers, which are the one-way elements in the cable TV systems, need to be replaced — a similar exercise to what is required to increase system capacity. If the cable system has not been modified for two-way transmission, the upstream signal may be sent by telephone, although this is not a particularly desirable arrangement since it requires two separate connections, which may lead to coordination problems.

Since cable modems operate using packet switching protocols, much like local area networks, the total bandwidth that they occupy will depend on the usage patterns of the customers. Therefore, instead of attempting to estimate the amount of capacity that will be used, we will describe how the network can be continually modified to accommodate the data needs of the cable modems.

If the cable system can carry signals in both directions, the low data rate "upstream" signals will be carried at frequencies below the broadcast band which are currently not used. These signals will have no effect on system capacity. The constraint is "downstream," where the high-speed data flows will occur.

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43 The National Cable Television Association reports that, in March 1997, CableLabs (the cable industry's research and development consortium) and its members announced the finalized radio frequency (RF) segment of the Data Over Cable Service Interface Specification (DOCSIS), which will allow CableLabs to certify that modems/set-tops meet the standards for interoperability and could lead to lower cost modems in 1998. Currently, CableLabs and its members have established a formal path of certification for cable modem equipment suppliers to obtain and "interoperability seal" for their high-speed data delivery devices based on the MCNS/DOCSIS specification. A certification board has been established that will assure that cable operators are buying modems that meet the new universal compliance standards. *See* National Cable Television Association Website at ,http://www.ncta.com/overview98_1.html>, September 14, 1998.

44 *See* "Cable Data Modems," published by CableLabs, April 1996.

These "downstream" signals can be carried within a 6 MHZ channel at various data rates, depending upon the modulation system being used. The systems must be traffic-engineered to be sure that there is adequate capacity for the traffic loads being offered by the users. If a single 6 MHZ channel becomes inadequate, then additional channels can be used, if desired. Alternatively, the cable operators may decide to reduce the number of homes passed by a coaxial cable section, therefore reducing the data traffic load, by increasing the deployment of fiber optic lines.

A typical cable system will ordinarily use a large optical fiber cable "trunk" to feed a large number of coaxial cable "nodes." These nodes can vary substantially in the number of homes they reach, from as few as 500 to as many as 2,000. Each such node may in turn connect to a different fiber in the fiber optic cable, so there is effective reuse of the coaxial cable capacity. Therefore, if a cable operator finds a heavy cable modem load in a particular area, it can expand its fiber optic line, breaking a large node into several smaller ones and reusing the channels.

Cable operators, then, can treat cable modems as an opportunity, expanding their systems to meet this expected demand as well as other needs, or, if more economical, installing more fiber to limit the number of customers on a coaxial cable.

This is a market that is not speculative. It is real. Furthermore, unlike cable TV, it is not a monopoly. Telephone companies are rapidly deploying ADSL technology in their plant, which is an alternative means of providing high-speed Internet access. (This technology is only marginally suitable for video distribution, since it typically can handle only a single video channel, and often with less than full broadcast quality.) Cable modem penetration is small, so far, but many operators have offered the service[45] and still more have announced that they are preparing for it by upgrading

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[45] According to the National Cable Television Association, cable companies have expanded commercial cable modem services into approximately 87 markets throughout the U.S, and 13.9 million cable homes have access to residential cable modem services in 29 states, and 125,000 cable customers subscribe to the services. Cable operators are creating new on-line services, including @Home, Road Runner, Optimum Online, MediaOne Express, Bresnan Link, PowerLink and Charter Pipeline. *See* National Cable Television Association Website at ,http://www.ncta.com/overview98_1.html>, September 14, 1998. Cox has announced availability of *@Home* service to residences in Orange County, San Diego, Phoenix, Omaha, New England, Hampton Roads and Oklahoma City. (Testimony of James O. Robbins, CEO Cox Communications before the Senate Commerce Committee (July 28, 1998). Cox's Internet service had over 15,000 customers by yearend 1997 and 18,000 customers by mid-February 1998. (1997 Cox Communications Annual Report). In 1997, Cablevision began offering *Optimum Online* technology to link customers to the World Wide Web to homes in Connecticut and New York. (Cablevision 1997 Annual Report). Comcast reported expanded availability of *Comcast@Home* high-speed cable modem Internet access service. Comcast's high-speed Internet access was available to 1.1 million homes and had 16,000 subscribers as of March 1998. (1997 Comcast Annual Report). It predicted that availability would more than double by yearend 1998. (Comcast Summary Annual Report 1997). Time Warner has ordered one and a half million *Pegasus* advanced digital two-way set-top boxes that will provide high-speed Internet access. (1997 Time

(continued...)

their cables to two-way operation and increasing capacity.[46] As cable operators increase system capacity, they can easily accommodate the demands of digital television must-carry.

2. Voicegrade Services

Voicegrade services, typified by telephony, are a potentially large market in terms of customers and revenues. They have a much smaller bandwidth requirement than Internet access. The current technology of choice is to "channelize" the individual lines, dedicating a portion of the total bitstream to each equivalent line. At 64 KB/s, a 38MB/s channel can carry over 500 conversations (one way). Since voice conversations need two-way service, two channels are required for 500 conversations, but only one need be in the critical downstream portion of the spectrum. It is likely that, within the next few years, packet technology will be used for this application as well, in the same manner as cable modems currently operate. At that time, even more equivalent telephone lines can be accommodated within a single 6 MHZ channel. It is not clear at this time how much of this market the cable industry will attract, but it is potentially a large revenue generator for which the industry will need to provide whatever is required.[47] Where cable systems expand capacity to offer

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[45] (...continued)
Warner Annual Report and Testimony of Joseph J. Collins before the Senate Commerce Committee, July 8, 1998). TCI's high-speed Internet data service is currently being marketed to 500,000 homes in San Francisco, Hartford, Chicago, Dallas and Seattle, with additional market launches planned for 1998. (1997 TCI Annual Report and Testimony of Leo J. Hindery before the Senate Commerce Committee, July 28, 1998.)

[46] The National Cable Television Association cites industry estimates that, by year-end 1998, 44.8 million homes (47 percent) will be passed by two-way plant. *See* National Cable Television Association Website at ,http://www.ncta.com/overview98_1.html>, September 14, 1998. TCI predicted the merger with AT&T will yield an integrated package of services over a highly sophisticated broadband network platform using a broadband infrastructure will consist of two-way capable systems upgraded to 550 MHZ and 750 MHZ . It also predicted TCI cable headends would utilize Internet-Protocol technology, which will allow offering of video, voice and data services in electronic "packets" over the same wire. (Testimony of Leo J. Hindery before the Senate Commerce Committee, July 28, 1998.)

[47] During 1997, the cable industry reached interconnection agreements in 37 states and the District of Columbia. *See* National Cable Television Association Website at http://www.ncta.com/overview98_1.html>, September 14, 1998. TCI has announced that the merged AT&T and TCI entity will compete aggressively in the local telephone market. (Testimony of Leo J. Hindery before the Senate Commerce Committee, July 28, 1998). AT&T announced it would spend an average cost of $400 per customer to provide IP telephony in TCI markets. ("AT&T outlines TCI upgrade costs, telephony strategy" Broadcasting & Cable, July 6, 1998, p.37). Cox announced launch of Cox Digital Telephone in Orange County, California and Omaha, Nebraska, and expansion within those markets and into other Cox cities. Cox also announced it was beginning to provide phone service packaged with high-speed Internet access services to residents of large apartment complexes. (Cox Communications Inc. Summary Annual Report 1997). In 1997, Cablevision reported that its *Cablevision Lightpath* served more than 1,000 high-end business customers and moved quickly into Connecticut and throughout the New York region. Cablevision's *Optimum Telephone* residential phone services was launched in several Long Island
(continued...)

voice telephony, the incremental cost of adding capacity for digital television must-carry will be minimal.

3. Video Telephony

Finally, we consider video telephony. This is a market that has barely been invented. There are a few videoconferencing services currently on the market, but there is no commercially viable video telephone service currently in place, or even announced. Nevertheless, it is certainly possible that, as video compression systems get cheaper (and they, too, will undoubtedly follow Moore's Law) video telephony will become a real market. Even if only 10 percent of current telephone users buy it, it becomes an important business opportunity. The transmission characteristics are similar to cable modems, except that two-way transmission at the same rate must be accommodated. Currently, 1.5 MB/s using the MPEG-1 encoding algorithm provides VCR-like picture quality, which is more than adequate for such a service. In fact, there are commercially successful videoconferencing systems currently on the market which operate at 384 KB/s, and some as low as 128 KB/s. However, the lower the bit rate, the poorer the picture quality and the more complex and expensive the compression system.

The serving arrangements the cable operators will need to deploy are the same as for cable modems; increased capacity, two-way operation and fiber optic deployment, all of which reinforce current trends.

It is not yet clear how all this will shake out. It is possible, however, that in less than a decade, many of these services will begin to take off. If the cable industry is to fully exploit these opportunities, it will need to have ample capacity in place to meet the needs. Unlike cable TV distribution, these services are competitive. The incumbent telephone companies, wireless carriers and satellite operators will be eager and competent to meet these demands if they materialize, so we can anticipate that the cable industry will position itself accordingly — in part by continuing to roll out increased capacity, both digital and analog, at a rapid rate for the foreseeable future.

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[47] (...continued)
communities. (Cablevision 1997 Annual Report).

E. Synopsis

A careful analysis of the trends in cable system technology suggests that cable operators will be expanding both analog and digital capacity at an unprecedented rate in order to deploy their own digital television services and to win the race with telcos and others for the high-speed Internet access business. The cable industry can also be expected to add capacity in order to offer voice telephony and to position itself for video telephone services. This capacity expansion should easily accommodate full digital television must-carry and the resulting "burden," would be less in relative terms, than the "burden" created by the existing must-carry rules. Moreover, if the FCC promptly mandates digital television must-carry (as it should), given the cable industry's already-announced plans to upgrade their systems, cable operators will incur little incremental cost in making certain that adequate capacity is available when needed. What is critical is that the Commission act now so both cable operators and broadcasters can plan efficiently for the transition.

VII. Conclusions and Recommendations

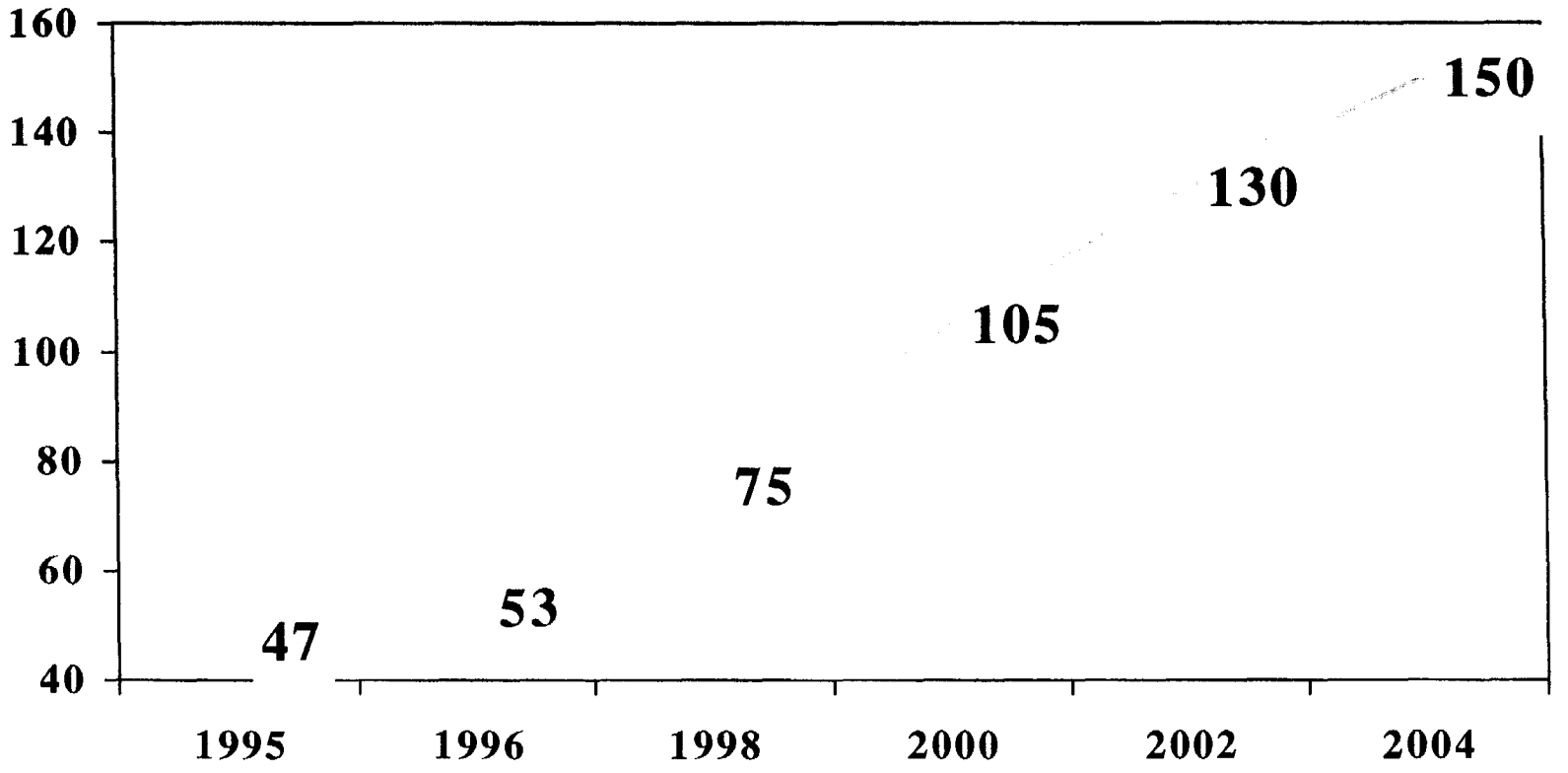
A must-carry obligation for digital broadcast television signals is a critical component of the transition to a universally available digital television service. Congress anticipated the important role that digital TV must-carry would play and has clearly mandated (as the Jenner & Block analysis shows) the FCC to modify its cable carriage rules to meet the statutory objectives.

In implementing Congressional intent, the Commission should mandate, during the transition period, that each new 19 MB/s digital signal be carried without modification of content and without degradation. Our analysis demonstrates that, much as was the case with the existing must-carry rules, cable systems, on average, have adequate capacity to carry these signals as they begin to be transmitted later this year without jeopardizing carriage of existing cable program services. This is particularly true since the number of digital television stations will be relatively small in the early years and concentrated in the large market, where capacity is typically greater.

Looking ahead, our examination of cable's already announced plans for expanding system capacity to provide their own digital services, Internet access and voicegrade services (as well as the potential for video telephony) demonstrates that cable systems will be adding substantial capacity in any event. As cable system capacity expands (and especially with the use of modulation methods which will enable cable operators to carry two 19 MB/s digital broadcast signals in one 6 MHZ cable channel), there should be more than enough room to accommodate additional digital TV signals as more stations begin DTV operations. A clear mandate from the FCC now for full digital TV must-carry will, therefore, permit operators to provide for the additional capacity at virtually no incremental cost.

In sum, then, given the opportunities for technological enhancement and for expansion of service offerings facing cable operators, capacity in the range of 200 to 500 channels (analog and digital) is easily within the reach of most cable systems over the next few years. Viewed in that context, requiring full digital TV must-carry during the transition would actually impose less of a burden on the average cable system in relative terms than the existing must-carry requirement. Contrary to the claims of some cable programmers, a full must-carry requirement will not threaten carriage of existing cable services or foreclose the addition of new cable in the future.

U.S. Cable Channel Capacity: Average System, 1995-2004



Source: Paul Kagan Associates, Inc. estimates, "Channel Logjam Eases -- Capacity Projections to 2004," *Cable TV Programming*, July 31, 1996.

APPENDIX E

APPENDIX F

National Association of
NAB
BROADCASTERS

Edward O. Fritts
President & CEO
1771 N Street, NW • Washington, DC 20036-2891
(202) 429-5444 • Fax: (202) 429-5410
efritts@nab.org

May 29, 1998

Mr. Brian P. Lamb
C-SPAN
400 North Capitol Street, N.W.
Suite 650
Washington, D.C. 20001

Dear Brian,

As President Reagan once remarked, "There you go again."

In your recent letter to Congress, you repeat the same tired claim that the adoption of must carry in the 1992 Cable Act caused C-SPAN to be dropped in "over 10 million households," and that "we still haven't recovered all of those losses." That sounds like a great story. Unfortunately, as you well know, it isn't true.

C-SPAN and other cable programmers were required in the *Turner* litigation to come forward with evidence to support their claims that must carry resulted in loss of carriage. Here's what that evidence showed:

- Nationwide, cable operators continued to carry *99.8 percent* of the cable programming that they carried before must carry.

- In October 1992, when Congress adopted must carry, C-SPAN was carried on 4,253 cable systems. In September 1994, more than a year after must carry went into effect, it was carried on 4,799 systems. By March 1995, it was carried on 5,200 systems, almost a 25 percent *increase* in cable carriage.

- When must carry was enacted, C-SPAN 2 was carried on 933 systems. In September 1994, carriage had gone up to 1,200 systems, and it was seen on 1,357 systems by March 1995. Thus, after must carry, the number of cable systems showing C-SPAN 2 went *up* by more than 45 percent.

- The same is true if you look at subscribers. In October 1992, C-SPAN was available in 53,600,000 households. That number went up by September 1994 to 58,640,000, and continued to rise to 62,400,00 households in March 1995. That's more than a 16 percent *increase*. For C-SPAN 2, it could be seen in 24,300,000 cable homes before must carry and in 37,000,000 in March 1995. Instead of losing households as you claimed, the subscriber figures you produced under oath show that C-SPAN 2 *gained* more than 52 percent in household availability after must carry.

- While you now claim that must carry resulted in C-SPAN's being dropped from cable systems, you told the FCC that its rate regulation rules were the reason C-SPAN was being dropped.

- At C-SPAN's deposition in April 1995, your witness was asked under oath to identify each cable system from which C-SPAN had been dropped because of must carry. You were only able to identify *eight* cable systems (out of more than 11,000) where you claimed C-SPAN had been dropped, and eight more where C-SPAN 2 had allegedly been dropped. As the deposition revealed, for most – if not all – of those systems, you had no evidence that must carry was the cause of the drop. Indeed, in one of the eight systems where you claimed C-SPAN 2 had been dropped, the evidence showed that the reason claimed by the cable system was "that all viewership surveys consistently demonstrate that C-Span 2 is the lowest viewed service on their line-up."

The evidence of C-SPAN's own witness and documents is that, after must carry, C-SPAN and C-SPAN 2 were both carried on more cable systems and seen in far more households than before. You couldn't prove your claims of losing millions of viewers in court; it's time to stop peddling the same old line to Congress.

Kindest regards,

cc: House and Senate Leadership
Members of the House and Senate Commerce Committees
Members of the House and Senate Judiciary Committees
Members of the Federal Communications Commission

C-SPAN
A PUBLIC SERVICE CREATED
BY AMERICA'S CABLE
TELEVISION COMPANIES

Brian P. Lamb
Chairman and Chief Executive Officer

May 22, 1998

Dear Representative

As you are well aware, the rush is on toward digital technology in the cable television and broadcasting industries. All parties involved are working rapidly to meet the FCC's accelerated schedule as local broadcast stations prepare to simulcast their new digital signals to viewers, just as the Congress has prescribed. However, amid all this activity we at C-SPAN are having a terrible sense of *déjà vu*.

It wasn't so long ago that we were badly burned by the 1992 Cable Act. As a direct result of a resurrected must carry rule and the new retransmission consent provision, our carriage of the House of Representatives and the Senate was reduced or eliminated entirely in over 10 million households when C-SPAN and C-SPAN 2 were dropped from cable systems as operators scrambled to comply with the law. Even 5 years later, despite the extraordinary commitment of the cable industry and its leaders to keeping C-SPAN and C-SPAN 2 on systems, we still haven't recovered all of those losses.

Now, incredibly, it looks like it could happen again. This time the threat to our non-profit and purely public service programming is the possibility that must carry status could be granted to every local broadcaster's new digital channels.

Let me be absolutely clear on this point: if 'digital must carry' becomes law, C-SPAN and C-SPAN 2 *will go dark* in millions more American households.

The outcome is certain. It happened to us in 1993 and thereafter, and not enough has changed in the law, regulations, or the economics of the television business to lead to any other conclusion.

I tell this to you now (and to your colleagues on the telecommunications committees and in the leadership) because we waited too long last time to get our story out. Seven years ago in my testimony to the House telecommunications subcommittee I had only two messages for Congress on must carry. First, that if must carry became law, our public service efforts would be seriously harmed. They were. And second, that C-SPAN was not asking for any special favors for itself. Instead, we became second class citizens when the must carry rule forced us to take a back seat to every broadcast signal in a cable system's service area.

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202. 737. 3220

This time around, however, it may not be too late to get our message across. So much about the actual implementation of digital television is still up in the air. Nevertheless, many smart people in the free market are coming up with solutions to make the new technology work for themselves and their future customers. Unless Congress and the FCC take the same approach to their jobs, we could easily be saddled with old-think rules for a brand new technology. Merely applying the analog-era must carry rule to digital television would be a mistake, and a disaster for us, even assuming "best case" scenarios in cable systems across the country.

For example, a typical 59-channel cable system in "Anytown, USA" with no empty channels that carries C-SPAN and C-SPAN 2 could easily be required to carry at least 10 local broadcast stations (see the enclosed channel lineup). Even if each local broadcaster chose to create only one additional digital channel, the "Anytown, USA" system's must carry obligation would expand by *at least* 10 additional channels. The cable operator would then be forced to eliminate 10 existing programming services now watched and valued by his or her customers. (This is a "best case" scenario for us--even more satellite programmers would have to be dropped if a broadcast station used the new technology to create more than one channel within its new spectrum allocation.)

A cable operator's commitment to *both* C-SPAN and C-SPAN 2 (or to any programmer, for that matter), will be sorely tested under those circumstances. Our experience with must carry last time around tells us that C-SPAN and C-SPAN 2 will take a big hit with digital must carry, and it could start as early as later this year when the first digital channels become operational.

There is much more to be said about C-SPAN and digital must carry, and it cannot all be said in this letter. For now, however, I wanted you to be aware of our bitter experience with the must carry rule, and of our certainty that history will repeat itself unless Congress takes another look at must carry in the digital context.

I hope we will have an opportunity to discuss this in person before too long.

Cordially,

Brian

Brian P. Lamb,
Chairman

Enclosure

Similar letters sent to Congressional leadership and to the House and Senate communications subcommittees.

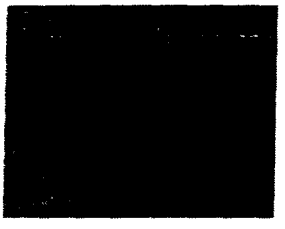
If you were the cable operator...which 10 channels would you take away from your customers?

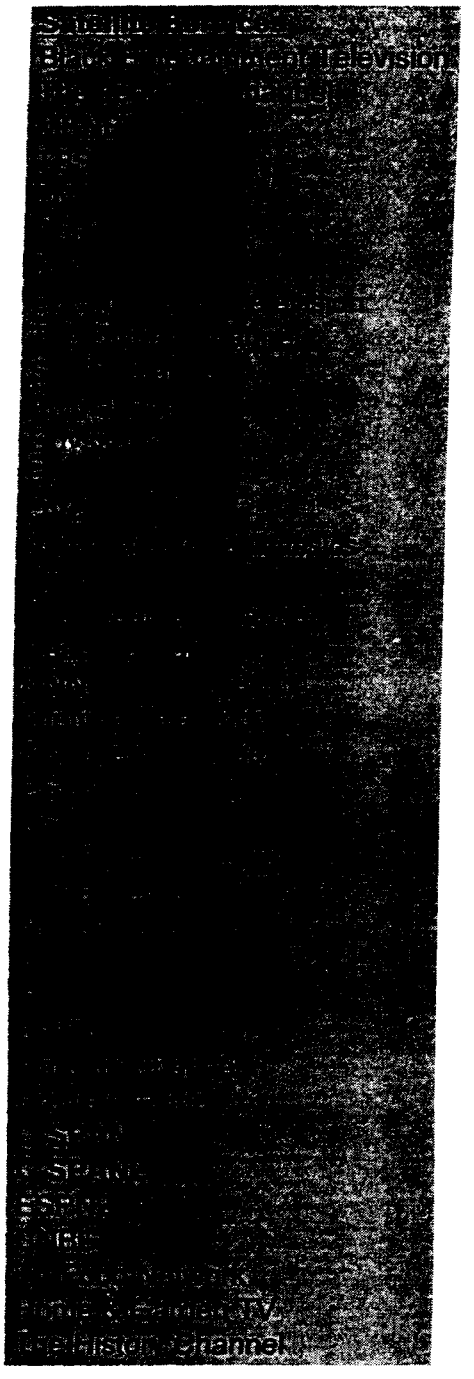
To make room for a "digital must carry" program signal from each of the broadcast stations in Anytown, USA, this fictional but typical, 59 channel cable system -- with no more available channel capacity -- would be forced to delete at least 10 satellite delivered program services (shaded) from its lineup.

Anytown, USA
Cable Television Program Channel Lineup

"Must Carry" Broadcasters
ABC
CBS
NBC
PBS
PBS
FOX
WB
UPN
Independent
Independent

Access Channels
Public Access
Government Access
Educational Access





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C-SPAN Networks in Jeopardy?

Main Page | Congress | FCC | Sample Channel Lineup | Communicate
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C-SPAN's Warning Prompts NAB Response

Shortly after C-SPAN's letter was sent to the Congress, the National Association of Broadcasters responded with a letter addressed to C-SPAN CEO Brian Lamb challenging C-SPAN's claim that the `must carry' rule was the reason C-SPAN and C-SPAN 2 had been dropped from cable systems in 1993 and thereafter.

The letter, from NAB President and CEO Edward O. Fritts, focused on information generated from C-SPAN's lawsuit challenging the consitutionality of the rule. Although most of the facts in the NAB letter are correct, they do not contradict C-SPAN's claim that millions of households were and continue to be denied full access to the C-SPAN Networks as a result of the `must carry' rule alone.

Most significantly, however, the NAB response does not challenge C-SPAN's warning to Congress that if full `must carry' status is granted to all digital television signals, millions of Americans will lose the C-SPAN Networks' coverage of their government.

The full text of the NAB letter is below. It is followed by a brief statement issued by C-SPAN in response.

NAB BROADCASTERS

Edward O. Fritts
President & CEO
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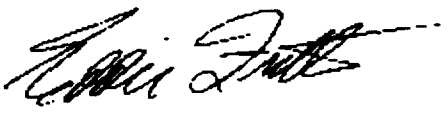

cc: House and Senate Leadership
Members of the House and Senate Commerce Committees
Members of the House and Senate Judiciary Committees

Members of the Federal Communications Commission

Read Full Text of C-SPAN Response to NAB.

C-SPAN HOME | WATCH AND LISTEN NOW | GUIDE TO PROGRAMS
C-SPAN IN THE CLASSROOM | CONTACT US | ABOUT C-SPAN | SEARCH | SHOP C-SPAN

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APPENDIX G

ATTACHMENT G

Technical Issues Surrounding Digital Must Carry

Prepared For NAB Comments on Digital Must Carry
(CS Docket 98-120)

by:

Lynn D. Claudy
Senior Vice President, Science & Technology

Arthur W. Allison III
Senior Engineer

NAB Science & Technology
Washington, DC

October 13, 1998

TECHNICAL ISSUES SURROUNDING DIGITAL MUST CARRY

This appendix covers technical issues raised in the *Notice* concerning interoperability between DTV signals, cable systems and DTV receiving systems. The discussion here focuses on broadcast carriage of DTV signals on analog cable channels, interoperability of set-top boxes with DTV receivers, channel navigation issues and the development of "cable-ready" DTV receivers.[1]

I. Carriage of DTV Signals Works Over Analog Cable Channels.

On an analog cable system, the simplest method of adding a broadcast DTV signal is to place the broadcaster's 8-VSB signal in a 6 MHz slot in the cable spectrum. This results in the lowest costs for both headend equipment and in-home hardware, but this approach utilizes the maximum amount of cable spectrum. This approach does not require a set top box at all, but it will only serve those consumers who purchase a digital television receiver or a commercially available digital set top adapter. In the case of the adapter, the digital signal is converted into an NTSC signal with its output either at an appropriate channel number (such as channel 3 or 4) or at baseband. In the event the cable subscriber requires no analog or digital set top box, this simple approach will allow direct connection to the subscriber's

[1] We note that the basic need for DTV cable carriage from a technical perspective is that of providing technical certainty to meet consumer expectations. If over-the-air services is marginal or non-existed, cable carriage is a familiar remedy. Providing broadcast service to areas that are underserved by over-the-air signals is the very reason that cable service came into being in the first place. NAB has urged the Commission to revisit their previous decision to leave DTV receiver performance strictly to marketplace forces; receiver technical standards are needed to improve

DTV-capable hardware and a minimum of difficulties. The connection to make this work when there is a set-top box is a little more complex but easily within the skill of a cable installer.

If the cable operator were allowed to optionally combine two DTV 8-VSB signals into one 16-VSB signal at the cable headend, it would reap a 2-to-1 savings in cable spectrum compared to carriage of 8-VSB. It is reasonable to expect that such combining equipment will be relatively inexpensive since it does not have to decompress and process MPEG-encoded data. However, under this scenario, DTV television receivers would need to universally include 16-VSB reception capability so that this approach is not precluded. The VSB modulation methods have been designed to facilitate low cost receivers which operate in either 8-VSB or 16-VSB mode.[2] The degree of implementation of 16-VSB reception capability on early receivers is not known, but many, if not most, are expected to have such capability. The advantages of 16-VSB carriage for conservation of cable spectrum are indeed compelling. We ask that the Commission consider enabling such an approach to cable carriage of broadcast DTV signals by obtaining assurances from receiver manufacturers that they will incorporate the ability to process 16-VSB, as well as 8-VSB, signals.

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the margin for over-the-air delivery, reducing reliance on cable carriage to alleviate consumer uncertainty.

[2] 16 VSB is documented as Section 5 of Annex D of the ATSC DTV Standard (ATSC Doc. A/53).

II. Interoperability Standard For DTV Signals on Digital Cable Channels Needs Prodding.

The interoperability issues concerning carriage of digital broadcast signals on digital cable systems are complex. The cable and broadcast media differ in some aspects of the technical systems that will be used for distribution of digital television programs. For example, the cable industry has decided to use a different digital modulation method ("QAM") from that specified in the FCC DTV Standard for terrestrial broadcasters ("VSB")[3]. However, initial product announcements by manufacturers of DTV receivers indicate that there will be no DTV receivers available in 1998 or early 1999 that will accept such QAM-modulated cable signals[4]. Therefore, while the development of "cable-ready" DTV sets continues to be a laudable goal for the future, in the near term digital set-top terminals will be necessary for consumers to access digital cable programs. However, currently announced digital set-top terminal products will not include the necessary circuitry to decode all of the HDTV picture formats in the ATSC DTV Standard that will be universally used for digital terrestrial broadcasting. Consequently, successful delivery of digital broadcast signals via digital cable systems to consumers' DTV sets will require a universally acceptable method to "pass through" the broadcasters' digital signals from the cable system's set-top terminal to the DTV receiver.

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[3] *See* letter from Decker Anstrom to William Kennard, August 26, 1998, p. 1; also letter from Victor Tawil to William Kennard, September 16, 1998 p. 1.
[4] *See* HDTV Product Guide chart in The Digital Television Transition Guide, TWICE/CEMA, 1998.

The criteria for satisfactory carriage of digital broadcast signals is best characterized not by adequate subjective picture quality but rather as reliable delivery of a packetized data stream to the consumers' DTV receivers in such a manner that the original data bits are unaltered within their packets. The exact scheme used to transport the data packets from the headend to the subscriber's house could vary between media—cable systems may prefer to carry those data service packets via QAM modulation whereas broadcasters carry them using 8 VSB modulation-- as long as the bit stream as delivered to the subscriber's DTV receiver is unaltered from the broadcaster's original bit stream.

The implementation of this concept requires a standardized and universally available connection for data exchange between the digital set top box and the DTV receiver. The industry has generally settled on the IEEE-1394 standard as the high speed data exchange interface for passing audio/video transport streams from set-top terminals to DTV receivers, which has the support of relevant industry players. While much effort has been expended in industry committees to reach an agreement on all details of this inter-device interface, development of a completed standard languished until the FCC became involved. As an unfortunate result of this delay, this interface will not be universally present on DTV receivers scheduled for introduction this year. This standard and its ubiquitous presence on all set-top terminals and DTV receivers is critical to universal compatibility between DTV sets and cable systems. We stated in the NAB/MSTV June 4, 1998 letter to FCC

Chairman William Kennard (filed in CS Docket 97-80 on commercial availability of navigation devices):

"If common standards are to be achieved before incompatible and proprietary digital equipment —and the accompanying consumer confusion and frustration – becomes prevalent, the Commission must step in to jump-start and focus the standard-setting process."[5]

Chairman Kennard rightfully recognized the importance of the IEEE 1394 standard in his August 13 letter to the NCTA and CEMA, calling on these two industries "to work together to complete a baseline 1394 specification that will allow manufacturers to produce commercially viable, 1394-enabled digital television sets by November 1999. I see no reason why this should not be complete by November 1, 1998."[6]

In response to this challenge, Gary Shapiro of CEMA responded to the Chairman:

"1394 standardization is a high priority, and we are working aggressively to complete a 1394 interface standard by November 1, 1998, as you have requested."[7]

Likewise, Decker Anstrom of NCTA also responded to the Chairman's letter on August 26:

"With the cooperation of the Consumer Electronics Manufacturers Association ("CEMA") and the companies it represents, there should be no problem in completing a baseline 1394 specification by November 1, 1998, as you requested in your letter."[8]

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[5] *See* Letter to William Kennard from NAB and MSTV, June 4, 1998, page 3.
[6] *See* Letter from William Kennard to CEMA and NCTA, August 13, 1998, pages 1-2.
[7] *See* Letter from Gary Shapiro (CEMA) to William Kennard, September 10, 1998, page 1.
[8] *See* Letter from Decker Anstrom (NCTA) to William Kennard, August 26, 1998, page 1

There is little doubt that the cable industry and consumer electronics manufacturers are earnestly trying to come to an agreement on the IEEE 1394 standard and have made substantial progress toward that end since Chairman Kennard's request. But they have been trying to do this for several years and have found themselves stymied to complete the specification. As noted above, Chairman Kennard has drawn a 'line in the sand' at November 1, 1998 and rightfully emphasized the importance of coming to agreement. Hopefully, a completed specification will be presented to the Commission on that date. However, the history of this subject leads naturally towards skepticism. We will all rejoice if a complete and satisfactory IEEE 1394 specification is completed by November 1. If it is not, we urge the Commission to take a strong role in forcing the completion of such a standard.

We note that IEEE 1394 standardization has several aspects to it. Compatibility of necessity includes both 1) the physical aspects of the connectors along with the voltages and impedances of the circuits *and* 2) the bus's communications protocols. It does no good for the units to be able to plug into the same connectors if the communications protocols are incompatible.

The IEEE 1394 solution is also of no value unless it appears in a compatible form ubiquitously on *both* the digital television receiver and the digital set top box. We urge the FCC to obtain assurances that it will in fact appear universally on these devices. Absent voluntary assurances, the FCC should mandate its use, with recognition that it is not meaningful to impose a requirement on one device without

imposing a corresponding requirement on the other device. There can be no "interface" without compatibility on both sides of the connection.

The main benefit of IEEE-1394 from the perspective of the cable operator is that it would allow the cable operator to utilize QAM modulation even if the digital receiver did not respond to QAM modulation. While IEEE-1394 would allow cable operators to use a QAM modulation scheme on cable rather than the VSB method chosen for broadcast use, it is of value *only* in those situations where the subscriber has a digital set top box equipped with the interface and the television receiver has a compatible interface. Thus the cable subscriber who chose to take analog cable services, but not digital cable services, and who purchased a digital receiver with a compatible interface for use in a cable system which used QAM modulation would have no benefit from the digital interface with respect to cable interoperability.

III. Other Proposed Cable-DTV Set Interfaces Are Not A Replacement for a Fully Developed IEEE 1394 Standard.

Alternatives to the IEEE 1394 interface for carriage of broadcast DTV signals have been suggested. In Chairman Kennard's August 13 letter to NCTA and CEMA, he states that "set-top box makers could build a device that would deliver a high-resolution component video signal to the proper input on a digital set."[9] In CEMA's response letter of September 10, Gary Shapiro refers to the recently approved CEMA Standard EIA 770, which is a three-part standard for component video connection of analog broadcasts (NTSC), SDTV and HDTV. This is a notable

accomplishment but this interface as a carriage interface "solution" must be looked at with some perspective.

First, the same argument of ubiquity needed for an IEEE 1394 connection must be applied to the component video connection. If this is to be the standard interface between DTV receivers and set-top boxes, it must be present on all set-top boxes and all DTV receivers. Secondly, this solution implies that the set-top box would have the ability to fully decode all broadcast video formats, including HDTV, increasing the cost of the set top box significantly from a set top box that has SDTV-decoding capability only. We are not aware of any set-top box manufacturer that has announced plans to include such HDTV-decoding capability. Further, from the consumer cost point of view, this is a needlessly expensive solution since the HDTV-decoding capability would be redundantly duplicated in both the set-box and the DTV receiver in the consumer's home. One way or another, the consumer ends up paying twice for the same capability of decoding high definition picture data and digital audio, which are silicon-intensive, and hence costly, operations. [10]

The IEEE 1394 standard has another advantage compared to the component video input with respect to connecting multiple inputs to the receiver. The IEEE

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[9] *See* Letter from William Kennard to NCTA and CEMA, August 13, 1998, page 2.
[10] However, these digital circuits follow the well-known Moore's Law which confirms the experience that digital integrated circuits are reduced in cost by approximately half every eighteen to twenty four months. The converse of this law is that for the same price, the number of transistors available for implementation of advanced functions approximately doubles every eighteen to twenty four months. Moore's Law gives confidence that digital set top box technical capability will rapidly become both more capable and more affordable. Thus what is possible now will be

1394 standard is a "bus" standard and allows "daisy chaining" of many devices. With component inputs, the receiver would need to have as many component input connectors as there are devices to be connected to the DTV receiver. Clearly, with multiple devices such as a cable set-top box, VCR, satellite set-top box, DVD player and others all possible within a consumer media room setup, the advantages of a guaranteed IEEE-1394 connection compared to component inputs are obvious.

IV. Completion of the Technical IEEE-1394 Interconnect Standard Should Not Be Dependent on Copy Protection Standardization.

The Commission has noted that copy protection is a concern to copyright holders, specifically that digital signals "in the clear" open the possibility of copies that are virtually as good as the original. The Commission asks in the Notice whether it should explore the subject in further detail in this proceeding.

In our view, it is important to recognize that the copy protection standard and the technical specification of the IEEE-1394 standard are separable processes; i.e., the technical standard can be completed and agreed upon separately from decisions concerning a copy protection standard. These issues are also separable in that the copy protection rules do not generally directly impact the broadcast services, which are delivered free over-the-air. While this is likely to be the case in many if not most broadcast transmissions, there may be situations where copyright owners are insistent on such protections even in the broadcast environment. To some extent,

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practical in just a few years. What is practical now will be easily affordable in just a few years.

this is an issue for the contractual details between broadcasters and holders of copyrights. We do not have a position on whether this is a matter for the Commission to decide, but we do reiterate that completion of the IEEE 1394 technical interconnection standard and its deployment in DTV sets need not be dependent on a copy protection standard being in place. The Copy Protection Technical Working Group (CPTWG) and the CEMA technical committee working on this issue are in the process of finalizing a copy protection standard. The recent September 23 announcement by five companies (Hitachi, Intel, Matsushita, Sony and Toshiba) of the availability of their Digital Transmission Content Protection method for copy protection of material transferred across the IEEE 1394 interface is an indicator of positive progress in the actions of the CPTWG.[11] However, agreement on a copy protection standard may toake more time to reach and requiring it to be a component of the baseline 1394 solution would further delay availability of 1394-equipped devices, effectively unreasonably denying access to free TV to those who only wished to watch free TV over cable.

V. The FCC Must Facilitate DTV Channel Navigation.

In addressing channel navigation issues, it is important to realize that digital transmission is very different from what we are used to. Today a composite signal made up of video and audio is created and transported as a whole. In digital there are a bunch of data 'packets' (188 byte long pieces), each with an identification

[11] *See* Press Release of Digital Transmission Licensing Administrator, San Jose, CA,

number. The consumer receiving device has the task of picking out the packets with the numbers it needs to perform the task the consumer requested. This may be making a picture or creating sound, or doing both in synchronization to deliver a television program. It also may be adding interactive data elements to enhance the appeal of the program. Something has to tell this receiving device how these 'packets' are related and how to use them. There are several possible ways to do this. The minimum societal cost solution would be if all transmission and reception devices used the same method. The ATSC and the Society of Cable Telecommunications Engineers (SCTE) created a standard method to do this for terrestrial broadcast and cable respectively. This standard is known as the Program and System Information Protocol or PSIP. The SCTE labels this standard as document DVS097.[12] The ATSC has approved and published this standard as document number A/65[13].

The PSIP standard provides the place to put the information needed to associate the packets of information delivered by VSB or QAM, into audio, video, and/or enhanced presentations with consumer interactivity. It also contains information for the TV Parental Guideline System, facilitates advance notice of programming and the closed captions the programs contain, and provides a

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September 23, 1998.

[12] Approved by SCTE ballot on 1/12/98, it has no technical objection remaining unresolved, but it has not been forwarded further in the normal ANSI approval process typically followed by SCTE, allegedly because SCTE feels some operational transition issues have not been resolved.

[13] Approved by ATSC by ballot on 12/22/97.

consistent channel selection method that builds upon existing channel brand awareness while allowing expansion for new program services.

Certain portions of the cable industry have a long history of actions which disrupt the transition to DTV by promoting technical implementations that preferentially benefit their organizations.[14] While one cannot fault them for protecting their interests, it is important for the Commission to realize what is really occurring and prevent further self–serving obstacles to the smooth navigation and delivery of digital programs to the consumer.

Another such effort appears to be underway to place obstacles for consumers into the path of smooth interoperability of delivering DTV signals over cable. Certain cable industry elements are now attempting to get approval for a draft standard for carriage of the navigational information on cable in a way that is different from the manner specified in PSIP. This effort is in the form of a proposed standard now being balloted. It is labeled SCTE DVS 147, and it documents the so-called out-of-band method currently used by some equipment to provide navigational information. These legacy systems are already documented, but this document is crafted to be a standard for information delivery, which could be used by some cable systems *instead* of the in-band PSIP data. If this standard is allowed

[14] The use of VSB versus QAM on cable systems is a prime example. The technical differences in performance have no significant business impact, as each can deliver the same number of channels for about the same costs. The engineers will quibble over this or that supposedly important detail, but 16VSB delivers 38.8 Mbps and 256 QAM delivers 38.8 Mbps. Perhaps the fact that the classic cable vendors would have had to obtain intellectual property rights to use the 16 VSB format from a competitor could be one reason for this obstacle to interoperability.

to be used as a replacement instead of a supplement, this would create another barrier to cable-ready DTV sets, or at the minimum raise the implementation cost as DTV sets would have to have a second RF tuner to select this second channel of information. It also raises the cost of the commercially available navigation devices (per R&O in CS docket 978-80; FCC 98-116) for the same reason. Use of this out-of-band technology may also require patent license from incumbent cable equipment vendors, whose unjustified enrichment the Commission should not permit through inaction. This proposed standard also does not support carriage of the Voluntary TV Parental Guideline System that has been endorsed by the FCC.

The Commission should adopt the PSIP standard for communication of the program linkage information on all digital cable systems that deploy VSB or QAM distribution systems, and require that all digital program choices be included in that PSIP structure.[15] This step not only facilitates deployment of commercial navigational devices but also the introduction of cable-ready DTV sets. The Commission should not permit another debacle like the ongoing analog cable-ready set dispute, resolution of which is outstanding in spite of the 1992 Cable Act. Absent taking this proactive step to avoid consumer frustration and confusion, at the minimum the Commission must prohibit the cable operators' removal of any PSIP information contained in any digital broadcast signal (or transport stream if a

[15] It should be noted that essentially all of the PSIP standard is required in order to deliver the TV Parental Guidelines information in a terrestrial broadcast and therefore the extension to include the cable specific elements of PSIP for cable to facilitate consumer navigation is a small but very positive step.

dedicated communications link is established) delivered to a cable system headend from a broadcaster.

There is no direct incremental cost that results from requiring that cable systems keep PSIP in the broadcast DTV signal. In fact, it would take additional equipment to detect the packets that contain PSIP information and extract them. If a cable system desires to add the capability to create program navigational information that covers the entire cable system, the PSIP structure supports that functionality. The broadcast PSIP could actually facilitate automatic systems to convert the input PSIP to the cable PSIP. This optional additional service would require additional equipment in the head end, but its deployment would be at the option of the cable system.

A noteworthy principle is that those consumers who purchase DTV devices should be the ones who benefit from the new programs and services delivered over DTV. The existing NTSC viewers may or may not see what looks like a vacant channel if they tune their NTSC tuner to the RF channel containing a DTV signal. Many modern set-top boxes and TV sets have the capability to scan for channels that contain an NTSC signal and exclude those that do not from further channel surfing. Those devices will simply skip over the "empty" channel, either automatically, or after the consumer deletes the channel from the selection pool.

VI. The FCC Should Encourage The Development of "Cable-Ready" DTV Receivers.

Ultimately, incorporating the ability to receive digital cable signals by direct attachment to DTV receivers is a highly valuable goal, enriching the value of the DTV receiver to consumers. However, this requires confidence on the part of DTV receiver manufacturers that cable systems will adhere to a known transmission standard. While the cable industry has a standards organization, SCTE, that has developed a set of standards for digital cable transmission, it is a voluntary set of standards and it remains to be seen if the cable industry adopts the universal use of the SCTE standards. The importance of this issue is highlighted in NAB and MSTV's June 4, 1998 letter to FCC Chairman William Kennard:

> "Common standards will assure consumers that they can purchase a DTV set or a set-top box that can receive undegraded digital broadcast television signals and can directly attach the navigational device or set to the cable system or MVPD. These standards are important because they permit consumer manufacturers to know what transmission formats need to be demodulated, what video and audio formats need to be decoded, how to connect with the security code of such transmissions, and how to have DTV receivers or TV monitors connect and communicate with the set-top boxes or other navigation devices that might be mediating such transmissions."[16]

A noteworthy goal of a interoperability with cable systems is to develop agreement on definition of a "cable-ready" DTV receiver, ultimately ridding consumers of the necessity for set-top boxes which add cost and confusion to the introduction of DTV into the home environment. In Gary Shapiro's September 10 letter to Chairman Kennard, CEMA's proposal for the standards and requirements associated with making a DTV receiver "cable-ready," as prepared by CEMA's

TV/VCR Caucus of the joint NCTA/CEMA Cable-Consumer Electronics Compatibility Advisory Group, was attached. We endorse the eight "essential elements" included in that proposal, reproduced below, and like CEMA, lament that no response to the proposal from NCTA has been forthcoming. We ask that the Commission exercise leadership in helping to forge an agreement in this area:

"Therefore, the Caucus states that digital cable-ready receivers and digital cable television systems will:

1. Support "ATSC DTV Standard A/53, which describes the overall system characteristics of the U.S. Advanced Television System;

2. Follow RF performance recommendations per draft EIA-23 "RF Interface Specification for Television Receiving Devices and Cable Television Systems, which defines tuner and corresponding cable signal characteristics;

3. Tune cable channels per EIA-542 "Cable Television Channel Identification Plan" which lists the frequencies to be used for each cable channel;

4. Use in digital cable systems 64/256 QAM modulation as specified in SCTE Standard DVS-031 "Digital Transmission Standard for Cable Televisions" or 8/16 VSB modulation defined in ATSC Standard A/53, or both, at the election of the cable system operator and provide in digital television receivers the capability to demodulate all of them;

5. Support draft SCTE Standard DVS-093 "Digital Video Service Multiplex and Transport System Standard for Cable Television," which defines the MPEG-2 packetization of program material;

6. Use only the transmission video display formats defined in ATSC Standard A/53, Table 3 and SCTE Standard DVS-033 (table 2) "Submission on 'Class A' Issues – Profiles, Levels and Formats."

7. Use the "Program and System Information Protocol for Terrestrial Broadcast and Cable" ("PSIP") as provided in ATSC A/65 and in SCTE Standard DVS-097, which defines the in-band data format for tuning parameters, V-chip information, and on-screen electronic program guides; and,

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[16] *See* Letter from NAB to William Kennard, June 4, 1998, page 2.

8. Support emergency messaging, the mechanism for which is currently under review by industry committees (such as ATSC and SCTE) and the FCC.

It is understood that this set defines the necessary interface between the digital cable system and the "cable-ready" digital television receiver."

VII. Summary.

In summary, there are many technical alternatives available to cable systems as to how to deliver undegraded DTV signals to the consumer. The Commission must take a proactive role to prevent obstacles from being placed in the path of consumer access to free over-the-air digital television programs.