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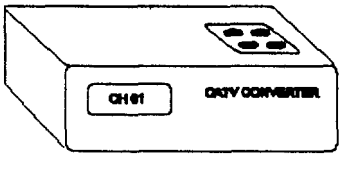
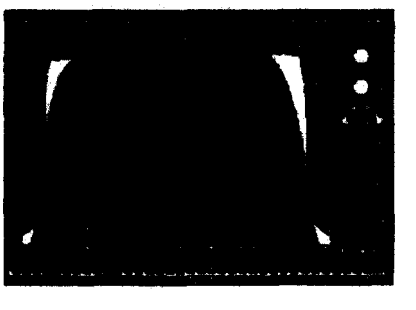
FEDERAL COMMUNICATIONS COMMISSION

93-7

CONSUMER ELECTRONICS AND CABLE SYSTEM COMPATIBILITY

REPORT TO THE CONGRESS





OCTOBER 1993

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EXECUTIVE SUMMARY

A number of compatibility problems have arisen between cable service and consumer electronics equipment, e.g., TV receivers and videocassette recorders (VCRs). These problems include difficulties in the use of VCRs to record programming and the operation of special features of TV receivers such as "Picture-in-Picture." In addition, cable practices often prevent the use of customer-owned remote control devices, both those that are supplied with receivers and VCRs as well as universal remote control devices that could be used to control both cable set-top devices and consumer equipment. Finally, there appears to be confusion on the part of consumers about the extent to which equipment is "cable ready" or "cable compatible." For example, current TV receivers and VCRs vary in their ability to tune the full range of channels offered by cable systems.

Section 17 of the Cable Television Consumer Protection and Competition Act of 1992 requires that, by October 5, 1993, the Commission, in consultation with representatives of the cable and consumer electronics industries, report to Congress on means of assuring compatibility between TV sets and VCRs and cable systems, consistent with the need to prevent theft of cable service. Section 17 also provides that within 180 days of that report, the Commission must issue such regulations as are necessary to ensure compatibility between consumer electronics equipment and cable systems.

In January 1993, the Commission issued a Notice of Inquiry requesting comment on the various issues relating to compatibility. In that action, the Commission indicated that the information to be gathered through the inquiry would be used in preparing the report to Congress and in formulating proposals for regulations in this area. Subsequently, representatives of the cable television and consumer electronics industries have worked together through the "Cable-Consumer Electronics Advisory Group" to address the various topics in the matter of cable equipment compatibility. This group submitted a number of measures to address both short term and long term compatibility problems. A key element of these measures is the development of a "Decoder Interface." This would be a new feature that would be incorporated in "cable ready" TV receivers and VCRs to enable use of component cable descramblers. The component descramblers would process signals after a consumer unit's tuner, thereby avoiding the current problems with set-top devices that disable features of consumer equipment related to tuning. Under this plan, cable systems that use scrambling would be required to provide component descramblers to subscribers that have Decoder Interface equipped receivers and VCRs.

This report fulfills the reporting requirement of Section 17. In the report, the Commission concludes that the most appropriate

course of action is to provide immediate relief for the existing base of consumer equipment; to require more substantial measures by both the cable and consumer electronics industries towards achieving significant compatibility in the near future; and finally to encourage the development of consumer equipment and cable technologies that are fully compatible in the long term.

The major provisions of this plan would:

- Prohibit the scrambling of signals on the basic tier of cable service.
- Require cable systems to provide a consumer education program to their subscribers. Such a program would include the notifications required under Section 17.
- Require cable systems to provide their subscribers with the option of receiving in the clear all signals whose reception does not require use of a converter.
- Require cable systems to provide supplementary equipment necessary to enable the operation of extended features and functions of consumer equipment.
- Require cable operators that offer subscribers the option of renting a remote control unit to notify subscribers that they may also purchase a commercially available remote control device and to permit the operation of their set-top devices with such commercially available remote control units.
- Require cable systems to use the EIA/ANSI IS-6 channel plan.
- Adopt new standards for all consumer electronics equipment that is marketed as cable ready. These standards shall include:
  -- a Decoder Interface connector;
  -- the ability to tune all of the channels specified in the EIA/ANSI IS-6 standard; and
  - improved tuner performance and shielding.
- Require cable operators that use scrambling systems to provide component descramblers. Cable systems would not be allowed to charge separately for the component descramblers.

The continued use and development of cable signal delivery methods such as traps, interdiction, addressable filters and other clear channel delivery systems that eliminate the need for any additional equipment in the subscriber's premises would be encouraged. The Commission also states that, as required by Section 17, it will continue to monitor such developments and reevaluate its compatibility requirements as warranted.

I. Introduction

In recent years, consumers have encountered an increasing number of compatibility problems between cable television service and the consumer electronics equipment, particularly TV receivers and videocassette recorders (VCRs), that they use with their cable service. In light of these problems, the Congress, through Section 17 of the Cable Television Consumer Protection and Competition Act of 1992 (1992 Cable Act), has legislated that the Federal Communications Commission develop a regulatory program to ensure compatibility between cable service and consumer electronics equipment.[1]

Section 17 requires that the Commission study the cable/consumer equipment compatibility matter and report to the Congress on methods for ensuring compatibility within one year of the enactment of the 1992 Cable Act, i.e., October 5, 1993. Section 17 further requires that thereafter, the Commission must adopt rules to ensure such compatibility within 180 days. This report fulfills the first step of the Commission's statutory responsibilities in this matter.

II. Overview of Cable/Consumer Electronics Compatibility Problems

The means employed by cable systems and consumer equipment to perform the various functions related to delivery and reception of cable service have tended to develop somewhat independently over the years.[2] As a result, a number of incompatibilities between the service provided by cable systems and consumer equipment have arisen over time. More recently, with the widespread penetration of VCRs, the introduction of advanced features in TV receivers and the increasing use of security technology by cable systems, these incompatibilities are now causing serious problems for consumers. These problems include difficulties in the use of VCRs to record programming and the operation of advanced features of TV receivers such as "Picture-in-Picture." In addition, current cable practices often prevent the use of customer-owned remote control devices, both those that are supplied with receivers and VCRs and universal remote control devices that could be used to control both cable set-top devices and consumer equipment.[3] Finally, consumers

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[1] Cable Television Consumer Protection and Competition Act of 1992, Pub. L. No. 102-385, 106 Stat. 1460 (1992), §17.

[2] This is due largely to the differing nature of the product objectives pursued by the cable and consumer electronics industries and the lack of an effective standards program to ensure a satisfactory interface.

[3] Set-top devices are also commonly referred to as "converters."

appear to be confused by the absence of any consistent definition of the commonly used terms "cable ready" and "cable compatible." For example, current TV receivers and VCRs vary in their ability to tune the full range of channels offered by cable systems. This section of our report provides an overview of the basic nature of the compatibility problems between cable systems and consumer electronics equipment.

A number of technologies and operating practices commonly employed by cable systems can limit the operation of various advanced features and functions of consumer equipment. The principal elements of cable system operation that tend to pose compatibility problems for consumer devices are channelization plans, set-top terminal devices, security systems that require use of a set-top device, and remote controls. Channelization plans involve both the frequency range of the channels delivered by a cable system, i.e., the number of channels provided by a cable system, and the specific frequencies to which the individual cable channels are assigned.[4] If a cable system offers more channels than a TV receiver or VCR can tune, i.e., uses a greater range of frequencies than the consumer equipment's tuning capability, that equipment will not be able to access all of the available cable channels when connected directly to the cable system. Similarly, if the frequencies of the channels delivered by a cable system are different than the frequencies of the channels to which a subscriber's TV receiver or VCR tune, the subscriber may receive no service, partial service or a mix of signals that appear on channel numbers that differ from their published locations.

The most troublesome compatibility problems arise from the use of set-top devices. These devices, which are discussed more fully below, are used by cable systems for several purposes: 1) as an element of their signal security systems; 2) to overcome channelization mismatches between cable service and consumer equipment; and, 3) as an interface to resolve various types of interference problems. The essential problem with set-top devices is that they generally replace the tuning functions of the TV receivers and VCRs to which they are connected. Set-top devices are connected between the input wire of the cable service and the signal input connector of the consumer device with which it is used. These devices typically contain a tuner, with a remote control feature, that is used to select a channel of cable service for viewing. Only one channel can be viewed at a time and that single channel is delivered to the subscriber's TV receiver and/or VCR on either channel 3 or 4, whichever is not used by a local broadcast TV station. In order to receive cable

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[4] Unlike the over-the-air broadcast television service, the Commission's rules currently do not mandate a channelization plan for cable systems.

service, the consumer equipment must be tuned to the output channel of the set-top device.

Because the equipment must be set to a fixed channel to receive cable service from the set-top box, features of the consumer's equipment that change channels, use timers to change channels or that receive more than one channel at the same time are effectively disabled. Thus, using a VCR to record one program while watching another, using a VCR timer to record sequential programs that are on different channels and operation of new features such as "picture-in-picture" are not possible with a set-top terminal box that outputs one channel at a time.[5] Similarly, the remote control features of TV receivers and VCRs are disabled when the unit is used with a set-top device. Cable security systems that use a set-top device to make protected channels viewable pose these same problems for compatibility by necessitating use of the set-top device's external tuner.

Cable systems typically offer their subscribers the option of renting remote control units to command set-top devices. Cable subscribers often are not aware of possibilities for using remote controls available from third parties to command set-top devices. In addition, cable systems in many cases disable, or fail to enable, the remote control circuitry of set-top devices if subscribers do not rent a remote control from the cable system. This practice precludes use of subscriber-owned remote controls that are otherwise technically capable of commanding the set-top device.

Consumer equipment that is not properly designed can also pose several types of operating problems when connected directly to cable service. The most common problem is that of "direct pick-up" (DPU) interference. This occurs when a TV receiver or VCR with inadequate radiofrequency (RF) shielding experiences interference from an off-the-air signal on the same channel as the cable channel to which it is tuned. A second problem that can occur from inadequately shielded consumer equipment is leakage of broadband cable signals. This can cause the cable system to exceed the Commission's standards for cable signal leakage and can result in interference to radio services

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[5] There are, to be sure, various alternatives for connecting consumer equipment that can resolve some of these tuning problems. In addition, there are some newer models of set-top boxes and certain additional equipment that have special features that can resolve some of these types of incompatibility problems. However, these solutions all involve varying degrees of additional expense, wiring complexity and operating requirements and in most cases do not render full compatibility. These alternatives are discussed more fully in subsequent sections.

operating on frequencies across the band operated by the cable system.[6] Moreover, in certain situations, a TV receiver or VCR can feed undesired signals back into the cable system, resulting in interference to other nearby cable users.

III. The Provisions and Requirements of Section 17, Other Relevant Sections of the 1992 Cable Act, and Existing Commission Rules

As a result of these problems of compatibility, the Congress set forth requirements to ensure compatibility between cable service and consumer equipment in Section 17 of the 1992 Cable Act. In addition, certain other provisions of the 1992 Cable Act that affect operating practices, in particular "buy-through" provisions of Section 3 and the "must carry/retransmission consent" provisions of Section 4, will also affect the specific regulatory choices for achieving compatibility. Finally, the Commission's existing cable regulations contain certain limited requirements relating to compatibility with consumer equipment.

A. Section 17

Section 17 of the 1992 Cable Act adds a new Section 624A to the Communications Act that addresses compatibility between consumer electronics equipment and cable systems.[7] In Section 624A(a), Congress makes the following findings with regard to this issue:[8]

- New and recent models of television receivers and video cassette recorders often contain premium features and functions that are disabled or inhibited because of cable scrambling, encoding, or encryption and by the use of cable devices, such as converters and remote control units, needed to receive programming;
- Consumers will be less likely to purchase, and electronics manufacturers will be less likely to develop, manufacture, or offer for sale, television receivers and video cassette recorders with new and innovative features and functions, if these problems are allowed to persist; and,

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[6] The standards for cable signal leakage are set forth in Sections 76.605(a)(12) and 76.611-.617 of the Commission's rules, 47 C.F.R. §§76.605(a)(12) and 76.611-617.

[7] See Section 624A, Section 17 of the 1992 Cable Act, supra.

[8] See Section 624A(a), Section 17 of the 1992 Cable Act, supra.

- Cable operators should use technologies that will prevent signal thefts while permitting consumers to benefit from such features and functions contained in new television receivers and video cassette recorders.

Section 624A(b)(1) specifies that, within one year of the enactment of the legislation, the Commission, in consultation with representatives of the cable and consumer electronics industries, must report to Congress on means of assuring compatibility between TV sets, VCRs and cable systems, consistent with the need to prevent theft of cable service, so that cable subscribers will be able to enjoy the full benefits of both the programming available on cable systems and the functions on their TV receivers and VCRs.[9] This section also provides that within 180 days of that report, the Commission must issue such regulations as are necessary to ensure compatibility between consumer electronics equipment and cable systems. Section 624A(b)(2) states that in issuing these rules, "the Commission shall determine whether and, if so, under what circumstances to permit cable systems to scramble or encrypt signals or to restrict cable systems in the manner in which they encrypt or scramble signals, except that the Commission shall not limit the use of scrambling or encryption technology where the use of such technology does not interfere with the functions of subscribers' television receivers or videocassette recorders."[10]

Section 624A(c) specifies that, in developing the rules required by Section 624A(b), the Commission is to consider:[11]

- The costs and benefits to consumers of imposing compatibility requirements on cable operators and TV manufacturers in a manner that, while providing effective protection against theft or unauthorized reception of cable service, will minimize interference with or nullification of the special functions of subscribers' television receivers or VCRs, including functions that permit the subscriber to--
  - -- watch a program on one channel while simultaneously using a VCR to tape a program on another channel;
  - -- use a VCR to tape two consecutive programs that appear on different channels; and,

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[9] See Section 624A(b)(1), Section 17 of the 1992 Cable Act, supra.

[10] See Section 624A(b)(2), Section 17 of the 1992 Cable Act, supra.

[11] See Section 624A(c)(1), Section 17 of the 1992 Cable Act, supra.

-- use advanced television picture generation and display features, and;

- The need for cable operators to protect the integrity of the signals transmitted by the cable operator against theft or to protect such signals against unauthorized reception.

Section 624A(c) further provides that the equipment compatibility regulations prescribed under Section 624A shall include:[12]

- Technical requirements with which a television receiver or VCR must comply in order to be sold as "cable compatible" or "cable ready";
- Requirements that cable operators offering channels whose reception requires a converter unit--
  -- notify subscribers that they may not be able to use the special features of their TV receivers and VCRs;
  -- to the extent technically and economically feasible, offer subscribers the option of having all other channels delivered directly to the subscribers' TV receivers or VCRs without passing through the converter unit;
- Rules to promote the commercial availability, from cable operators and retail vendors that are not affiliated with cable systems, of converter units and of remote control devices compatible with converter units;
- Requirements that cable operators who offer subscribers the option of renting a remote control unit--
  -- Notify subscribers that they may purchase a remote control from any source that sells such devices;
  -- Specify the types of remote control units that are compatible with the converter unit supplied by the cable operator; and,
- Prohibit a cable operator from taking any action that prevents or in any way disables converter units from operating with commercially available remote controls.

Finally, Section 624A(d) requires the Commission to review periodically and, if necessary, to modify the regulations issued pursuant to this section in light of actions taken in response to the regulations and to changes in cable systems, television receivers, VCRs and related technology.

B. Related Provisions of the 1992 Cable Act

Section 3 of the 1992 Cable Act amends Section 623 of the Communications Act to establish a basic tier of cable service

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[12] See Section 624A(c)(2), Section 17 of the 1992 Cable Act, supra.

that includes all broadcast stations carried by the system. Except where competition exists, this tier will be rate regulated.[13] As a further protection for subscribers, the "buy-through" provisions of Section 623(b)(8)(A) prohibit cable systems from requiring purchase of any tier higher than basic service as a condition of access to video programming offered on a per channel or per program basis.[14] This means that cable operators also need to selectively provide access to premium and pay-per-view services without restricting tiered services other than basic service. Section 623(b)(8)(B) grants a ten-year exemption from the buy-through provisions for cable systems that by reason of the lack of addressable converter boxes or other technical limitations, do not permit the operator to offer programming on a per channel or per program basis.[15] The Commission has recently adopted a Report and Order that sets forth rules to implement the buy-through provisions.[16] Section 632(l) of the Communications Act, as amended by Section 3 of the 1992 Cable Act, exempts video programming offered on a per channel or per program basis from the definition of cable programming that are subject to rate regulation.[17]

In addition, Section 4 of the 1992 Cable Act adds a new Section 614 to the Communications Act which provides that each broadcast station carried under the "must carry" provisions will be able to choose a channel position from among the following:[18]

- Its over-the-air channel number;
- Its position on the cable system on July 19, 1985; or,
- Its position on the system on January 1, 1992.

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[13] See Section 623(b)(7)(A), Section 3 of the 1992 Cable Act, supra.

[14] See Section 623(b)(8)(A), Section 3 of the 1992 Cable Act, supra.

[15] See Section 623(b)(8)(B), Section 3 of the 1992 Cable Act, supra. This exemption is not available to a cable operator after such time as the technology utilized by the cable system is modified or improved in a way that eliminates its technological impediments to complying with the tier-buy-through provisions.

[16] See Report and Order, MM Docket No. 92-262, adopted March 11, 1993, FCC 93-143.

[17] See Section 623(l), Section 3 of the 1992 Cable Act, supra.

[18] See Section 614(b)(6), Section 4 of the 1992 Cable Act, supra.

Section 614(b)(4)(B) requires that the Commission modify its must-carry rules to assure that cable systems carry local advanced television broadcast stations.[19]

C. Existing Commission Rules

Under the Commission's current rules, cable systems are subject to technical standards that specify minimum performance with regard to the quality of NTSC (or similar format)[20] video signals provided at subscriber terminals; delivery of closed captioning information; and signal leakage limits.[21] Related rules specify requirements for monitoring and measuring technical performance and resolving any interference resulting from cable system operation.[22] The Commission's rules currently do not address compatibility between cable systems and extended features of subscribers' TV sets, VCRs and/or related equipment.[23] Section 76.920 of the rate regulation rules requires that every subscriber must subscribe to the basic tier of service.[24]

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[19] See Section 614(b)(4)(B), Section 4 of the 1992 Cable Act, supra.

[20] "NTSC" is the name of the current analog television system. The term NTSC is derived from the name of the organization that developed this system, the "National Television Systems Committee." Some cable systems disassemble the NTSC video signal for transmission through their plant. The disassembled signal is reassembled prior to its delivery to subscribers. The reassembled signal is not in the NTSC format in all respects. However, it can be received and displayed by current TV receivers and is subject to our cable technical standards.

[21] See 47 C.F.R. §76, Subpart K.

[22] Id.

[23] Our existing rules only require that the cable television channels delivered to a subscriber's terminal be capable of being received and displayed by receivers intended for reception of off-the-air broadcast TV signals, as authorized under Part 73 of our rules.

[24] See 47 C.F.R. §76.920.

IV. Previous Industry Efforts to Resolve Cable/Consumer Electronics Compatibility Problems

The cable and consumer electronics industries have been aware of, and working on, the problems of compatibility between cable service and consumer equipment for a number of years. In 1986, the Consumer Interconnect Subcommittee of the National Cable Television Association's (NCTA) Engineering Committee issued a report that discussed existing and some proposed solutions to these problems.[25] In the same general period, the Electronic Industries Association/Consumer Electronics Group (EIA) and NCTA formed the Joint Engineering Committee (JEC) to address all issues relating to the interface between cable service and consumer equipment. The group has developed and continues to work on standards in two specific areas:

- A Uniform Channelization Standard: "EIA Interim Standard 6 (IS-6)."[26] This standard sets forth a plan for association of channel numbers with frequencies. IS-6 currently is in the process of being fully certified by the American National Standards Institute (ANSI). A new version of this standard is being released which amends IS-6 to cover the latest new channels in use in extended bandwidth cable systems.
- A Definition of the Desirable Characteristics of Reception Equipment to Be Connected to Cable: "IS-23". This JEC draft document, "CATV Interface Specifications for Television Receiving Devices" contains information on desired signal levels and their variation, tuning range, shielding required, local oscillator leakage and other parameters to be addressed to ensure a trouble-free connection to a cable system. The draft IS-23 has been under active negotiation since 1985 and, if finished, may include much of the functional definition of a "cable ready" device.

In addition, the EIA has developed a standard for a "Standard Baseband (Audio/Video) Interface Between NTSC Television Receiving Devices and Peripheral Devices" designated

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[25] See "Connecting Cable Systems to Subscriber's TV's and VCRs- Guidelines for the Cable Television Industry," NCTA's Engineering Subcommittee on Consumer Interconnection, 1987. A copy of this report is included as Appendix E.

[26] "EIA Interim Standard No. 6 (EIA/IS-6) Recommended Cable Television Channel Identification Plan," prepared by EIA/NCTA Joint Engineering Committee Channelization Working Group (May 1983). A chart showing the broadcast channels and the channels specified in EIA IS-6 is provided in Appendix G.

EIA/ANSI 563.[27] The JEC found that most of the interface problems arise from placing a set-top devices tuner ahead of the tuner in TV receivers and VCRs. The EIA/ANSI 563 "Decoder Interface" connector provides the means to locate the descrambler after the tuner of the TV or VCR, in a position on the back of the unit.[28] The decoder interface is a special plug connection generally mounted on the back of TV receivers and VCRs so equipped.[29] This plug allows access to the internal circuitry of the device to facilitate the operation of component descrambler circuits and other functions.[30] Unprocessed cable signals are received by the TV receiver or VCR and then passed through a component descrambler plugged into the units decoder interface. The descrambled signal is then passed back into the host device for display or other use. The cable service in this case connects directly to the subscriber's equipment and cable signals are selected on the tuner contained in the TV set or VCR. Descrambling is performed by the component descrambler after tuning, before the picture is displayed on the screen or routed through the recording circuitry.

The cable industry generally did not implement or support use of the decoder interface and the electronics industry therefore has generally discontinued its efforts to include the decoder interface connectors. Currently, the decoder interface connector is only included in a very few high end TV receiver models. The cable and consumer electronics industries, however, are now discussing the possibility of using a decoder interface device to resolve compatibility problems.

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[27] See "Standard Baseband (Audio/Video) Interface Between NTSC Television Receiving Devices and Peripheral Devices", EIA/ANSI-563-1990. A copy of the EIA/ANSI 563 standard is attached as Appendix H.

[28] The Decoder Interface connector was first introduced to the market in 1989, and over 1 million Decoder Interface equipped receivers were manufactured. While this standard was adopted, it has not been widely implemented. The Decoder Interface feature is also sometimes referred to as a "multiport" connector, because it was originally intended to support multiple applications in the consumer, cable, computer and related fields. Use of this term is now being discouraged by proponents of the Decoder Interface.

[29] This same plug is now mandated of TV receivers in France and much of the rest of Europe, and is also included in many sets sold in Japan.

[30] Additional description of the EIA/ANSI 563 Decoder Interface standard and its development is provided in APPENDIX C.

V. Consultations with Industry and Others

On January 14, 1993, the Commission issued a Notice of Inquiry (Notice) in this proceeding to solicit comment from all interested parties on the various issues relating to compatibility.[31] A copy of the Notice is provided in Appendix A and a list of the parties that filed comments thereon is presented in Appendix B. In addition, representatives of the cable television and consumer electronics industries have worked together through the "Cable-Consumer Electronics Advisory Group" (CAG) to address the various topics in the matter of cable equipment compatibility.[32] The CAG's initial joint submission addresses factual matters. The individual comments of parties participating in the CAG discuss a wider variety of issues, particularly legal and policy concerns, where the parties held differing positions, at least initially. The CAG subsequently filed Supplemental Comments after the close of the period for responding to the Notice. In its Supplemental Comments, the CAG presents a joint agreement between the participating consumer electronics manufacturers and the NCTA on proposals for a number of measures to address both short term and long term relief for cable and consumer equipment compatibility problems. In view of the significance of these proposals, which were agreed to by parties on both sides of the CAG, the Commission requested comment on this filing. Parties filing comments in reply to the CAG Supplemental Comments are also listed in Appendix B. The submissions of all of these various parties were used in developing the information presented in Sections VI to VIII of this report.

VI. Current Cable System Operations

A. Use of Set-top Devices

Cable service is connected either directly to the subscriber's receiving equipment or to the input of a "set top" device, which is then connected to the TV receiver or VCR. Set top devices may be either a basic converter or, in the case of a cable system that uses a scrambling security system, a converter/descrambler combined unit. Basic converters perform two major functions. First, they provide shielding that prevents

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[31] See Notice of Inquiry, ET Docket No. 93-7, 8 FCC Rcd 725 (1993).

[32] The CAG is an advisory group formed by representatives of the cable and electronics industries, including the NCTA the EIA and individual companies, to work with the Commission to try to facilitate implementation of the equipment compatibility provisions of the 1992 Cable Act.

leakage of cable signals and at the same time reduces interference to the cable system from external radio signals. Second, basic converters serve to provide access to channels in cases where the range of channels on the cable system is beyond the tuning range of the subscribers TV receiver or VCR. Cable systems use converters to resolve both types of problems. Converters change the frequency of the desired cable signal to an output channel in the broadcast TV band, usually channel 3 or 4, that is not used by a TV station in the subscriber local area. This output channel is then connected to the subscriber's TV or VCR. Converter/descramblers perform the above functions and also make viewable signals that are scrambled for security purposes.

Set-top devices also may provide a number of benefits, including:

- Improved tuning as compared to built-in tuners of TV receivers and VCRs, including reception of additional cable channels;
- Remote control/remote volume control on non-remote controllable consumer equipment; and,
- Parental control, by allowing individual channels to be blocked.[33]

In general, the only types of set-top devices that are commercially available from third parties are basic converters, i.e., those that do not include descrambling capability. Basic converters are widely available from a variety of sources, including both cable systems and retailers. Converter/descramblers may not be legally provided to cable subscribers from third parties without the permission of the cable operator. Currently, cable systems do not generally make scrambling converters available for purchase by their subscribers. A few cable systems do, however, make these devices available for sale.

The CAG estimates that approximately 15 million basic converters are currently in use. The EIA has conducted a consumer survey that indicates that more than one-third of subscribers to basic service and half of subscribers with additional cable services, have set-top boxes (this includes both basic converters and combined converter/descramblers). EIA submits that its survey also indicates that a very substantial majority of cable subscribers would prefer not to use a set-top box with their TV receivers and VCRs if they could still have

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[33] Continental points out that many TV receivers and VCRs do not have parental control features like those in set-top units that allow particular channels to be blocked from viewing by children.

access to the same cable programming.[34] Its survey further indicates that consumers spend an estimated $1.5 billion annually on set-top box and remote control rental.

B. Security

1. Need for Security

The NCTA and other parties representing cable interests state that, as Congress has recognized, cable piracy harms cable operators, cable programmers, franchise authorities and, ultimately, law-abiding subscribers. It points out that subscribers purchase programming, not electronics, so that it is essential that the industry be able to use security measures that adequately protect that programming from unauthorized use. NCTA and Time-Warner Entertainment Company, L.P. (Time-Warner) point out that, as the Commission observed in the Notice, theft of service is estimated to result in over $4.7 billion in unrealized revenue annually for the cable industry, or almost 24 percent of gross cable industry revenue in 1991.[35] NCTA states that cable piracy also hurts cable programmers because their advertising revenues and license fees are commonly determined by the number of subscribers legally receiving their service. Ultimately, the viability of providing programming that is customized to taste could be threatened. Franchise authorities similarly suffer because franchise fees are most often based on a percentage cable system revenues.

2. Security Methods

The cable industry currently uses three basic methods for preventing unauthorized reception of service: trapping, scrambling, and interdiction. These signal protection methods are used to control access by subscribers to some portion of the

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[34] Of the cable subscribers in the EIA survey who preferred not to use a converter box, 29 percent cited "convenience," 32 percent cited cost and convenience, and 12 percent cited cost alone as their reason.

[35] This estimate is from the "1992 Theft of Service Survey" conducted by the Office of Cable Signal Theft of the National Cable Television Association. Greater Media, et al. states that one year after switching to a more secure transmission system on one of their systems with a serious theft problem, basic subscriptions increased over 12 percent, HBO subscriptions increased almost 14 percent and additional outlets subscriptions increased 57 percent.

services available on a cable system.[36] These methods deny signal access through filtering, deleting portions of signals, adding carriers or other signals that interfere with reception of programming or encoding/scrambling of signals. Cable security systems also make use of addressable technologies. Addressability is the capability to control access by individual subscribers to particular program signals and other services electronically from a central location. Addressability allows the cable operator to selectively apply the method used to deny access to service, but does not constitute a form of signal protection method in and of itself. In other words, addressability must be used in conjunction with a signal protection method.

Trapping involves control of access to cable signals through use of one or more small filtering devices that are manually installed in the cable system between the feeder cable and subscribers' TV equipment. There are two basic types of traps, negative and positive. Negative traps are filters that remove the frequency of a specific channel from a band of frequencies. With negative trapping, subscribers who do not wish to subscribe to a specific program service have a trap installed at the junction point, called a subscriber tap-off, between the feeder cable and the subscriber drop cable. This allows passage of all channels except the protected service. Negative traps usually are used only where the penetration of a service is high, since traps only are needed those subscribers that do not take the protected service, and the subscriptions to the service are stable.

Positive traps remove one or more interfering carriers that are injected into a specific channel at the cable system headend. The interfering carrier(s) prevents proper reception of the channel. If a subscriber wishes to receive that particular service, a filter is provided that removes only the interfering carrier(s). This filter is frequently installed inside the home immediately before the TV set or VCR. Positive traps are used primarily in situations where a minority of subscribers take a service and those subscriptions are stable.

Both negative and positive traps are low cost devices, on the order of $5 apiece (the price range is typically $3 to $15). With positive trapping, certain headend equipment is also required to inject the interfering carrier(s) into the channel. This equipment costs approximately $1000 per channel. With all traps, however, there is an operational or life-cycle cost that significantly exceeds their capital costs. Since traps are not

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[36] Denial of access to the full schedule of programs on a cable system is generally accomplished by simply disconnecting service.

addressable and must be manually installed or removed, the installation charge associated with changing service levels at a subscriber's premises varies from $15 to $50. The amount of this charge depends on the salary of the technician, the cost of the installation truck, including maintenance and insurance, and the likelihood of finding the subscriber at home.

With scrambling technologies, a channel chosen to be security protected is altered at the cable system headend to make it unreceivable by standard television receivers. Descrambler units that correct the portions of the signal that have been altered are used by subscribers to restore the scrambled channel to viewable condition.

There are two primary methods of scrambling: radiofrequency (RF) and baseband. RF scrambling operates on a signal in its radiofrequency form without demodulation. RF scrambling methods generally suppress the synchronization pulses TV receivers use to locate the picture correctly on the screen by attenuating these pulses. Without the synchronization pulses, the picture is displaced on the screen, rolls or distorts into diagonal stripes. A descrambler attenuates the non-synchronization portion of the signal to restore balance in the signal. RF scrambling is an older, relatively simple technology and can be compromised relatively easily. In fact, the tuners of some TV receivers and VCRs contain circuitry that can unintentionally enable the equipment to partially display signals scrambled by this method. There are other variations of RF scrambling, such as the Zenith Phase Modulation (PM) RF system, that are more secure, but these variation are not as widely used as the basic RF scrambling method.

Baseband scrambling systems encode the signal before it is modulated onto its transmission channel and descramble it after demodulation. This approach provides much more flexibility and options in processing the signal. The earliest forms of baseband scrambling suppressed the synchronization pulse and inverted the video, which makes the picture look like a jumbled photographic negative. More advanced methods include line shuffling, which interchanges the order of the picture's lines, and line rotation, which splits the picture's lines and interchanges their left and right sides.

Descramblers can either be fixed or addressable. Fixed descramblers are programmable set-top units that are set to descramble one or more specific protected channels requested by the subscriber on a continuing basis. As with simple converters, the subscriber selects the channel to be viewed on the tuner in

the set-top unit.[37] If the selected channel is scrambled, the descrambler processes it to viewable condition. Non-scrambled signals are passed through without alteration. Changing the channels that are descrambled generally requires a service call to the subscriber's premises to alter or swap the fixed unit. These units are also vulnerable to tampering. Fixed descramblers are now considered to be obsolescent and are slowly being phased out by the cable industry. Addressable descramblers are electronically controlled from the headend to authorize or de-authorize service on particular channels on a continuing or intermittent basis, and can be used to support pay-per-view services.

There are two major types of addressable descramblers: integrated converter/descrambler units and component descramblers. Integrated converter/descramblers are set-top units that, from an equipment compatibility viewpoint, look-like and connect in the same manner as a fixed descrambler or a basic converter. Component descramblers do not contain a tuner. These devices connect to the subscriber's TV receiver or VCR through the EIA/ANSI 563 plug. The cable service is connected through an input port on the receiver or VCR and is passed to the descrambler after passing through the consumer unit's tuner. As indicated above, component descrambler units have not achieved widespread penetration and are not in general use now.

Most descramblers can process only one signal at a time, so that a separate descrambler is needed for simultaneous access to multiple scrambled channels. If one scrambled channel is to be watched and another recorded at the same time, two signals must be descrambled simultaneously. Similarly, if multiple scrambled signals are to be viewed at the same time, multiple descramblers must be used. There are a few models of dual descrambler models available.

The cost of the set-top boxes used with scrambling and addressable scrambling systems is generally in the range of $100-150. In addition, the basic headend equipment associated with such systems costs $10,000-15,000, plus an additional $2,000-3000 per scrambled channel.

Interdiction systems carry signals in the clear on the cable system trunk and feeder plant. At subscribers' tap-offs, a device is installed that can produce an interfering carrier on channels selected by the cable operator. This device is

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[37] Simple cable converters are devices that change the frequency of signals carried on a cable system to a channel in the broadcast TV band, usually channel 3 or 4. These devices also are used to prevent leakage of broadband cable signals due to inadequate shielding in TV receivers and VCRs.

addressable, so that the cable operator may turn specific interfering carriers off or on by an electronic signal from the headend. Channels not desired by the subscriber are thus "interdicted." All other channels enter the subscriber's premises in the clear. Current models of interdiction equipment can protect or interdict from 16 to 72 channels. Interdiction does impose additional power requirements for the cable system, as each subscriber module is separately powered.

The cost of interdiction equipment varies depending on the number of channels that must be controlled. Cable industry representatives generally submit that the cost of interdiction is about $100 per home passed, assuming that 16 or fewer channels are protected. In a typical system with 50 percent of homes passed and 50 percent of those homes taking one or more pay services, the cost for interdiction would be about $400 per premium service household. Interdiction equipment manufacturers, on the other hand, claim that the increased cost of interdiction would be offset by other benefits such as increased security, customer friendliness and higher subscriber retention rates.

It is difficult to accurately gauge the relative usage of the existing cable security methods. No national data bases exist. Cable industry representatives responding to the Notice indicate that the vast majority of cable systems use scrambling or trapping technologies, and often use a combination of both techniques, depending on their tier configuration and program service penetration level. A recent survey by Television Digest indicates that addressable equipment is used with about 37 percent of the total subscribers served by the top 100 cable operators.[38] This amounts to about 19 million households. Applying this rate to the overall cable industry, TV Digest estimates that there are 21 million households nationwide that receive cable service through addressable equipment.

Several cable operators have provided information on their own use of security technologies. For example, Time-Warner states that most of its systems that use scrambling employ a hybrid approach that includes negative and positive trapping and scrambling with either fixed or addressable descramblers. In these applications, traps are used for the popular premium services such as HBO and scrambling is used for less popular premium services and pay-per-view services. Intermedia Partners (Intermedia) indicates that its usage of security technology is as follows:

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[38] Television Digest, June 7, 1993, pp. 4-5. TV Digest also indicates that the top 100 cable operators now serve almost 96 percent of all basic cable subscribers in the U.S.

	Traps	Scrambling	Both
Percent Systems	69	25	6
Percent Subscribers	39	48	13
No. Subscribers (x000)	234	287	81

Cable industry representatives submit that in almost all cases, broadcast and public, educational and government access (PEG) channels are not scrambled. High penetration premium services are often trapped rather than scrambled. Pay and niche premium services are usually scrambled. Very few systems scramble most of their signals. According to cable industry sources, only a very small number of cable systems use interdiction, and those systems serve less than 80,000 subscribers.[39]

3. Comparative Merits of Existing Security Methods

Cable industry representatives state that the choice of security methods is based on a variety of factors, and that no one method is ideal for all situations. These parties indicate that the security method used must first be cost effective so that it does not present economic barriers that discourage subscribers' access to diverse programming. They also state that it is important that the costs of the security method can be associated with the subscribers to the protected channels. Third, cable industry representatives submit that the security system must be easy to use and result in minimal interference with the functions of consumer equipment.

The cable industry indicates that it judges the efficiency and effectiveness of individual security methods based on the following factors:

- Level of security: the degree of invulnerability to compromise or defeat.
- Hiding ability: the degree of unintelligibility of video and audio in a protected signal.
- Recoverability: the degree of freedom from impairments in the signal ultimately provided to the subscriber.
- Compatibility with addressability: the ability to make the signal protection method addressable.
- Channel incremental costs: In a channel incremental system, the protection of additional channels or blocks of channels requires more hardware; a non-channel

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[39] Scientific Atlanta submits that in the three years that its interdiction equipment has been available, this technology has been implemented in only fifteen cable systems.

incremental signal security method will control any number of channels without requiring additional hardware.
- Compatibility with consumer electronics: the degree to which certain consumer electronics features may be compromised when a subscriber chooses to take a service via the signal protection method.
- Cost effectiveness: the balance between affordability and the other aspects of signal protection.

Cable representatives indicate that positive traps, which remove interfering carriers, are used for low penetration services with stable subscriber bases. Negative traps, which remove channels from the drop cables connected to subscribers' premises, are used for high penetration services (such as HBO), again with stable subscriber bases. Traps are very subscriber friendly, in that they deliver all purchased signals "in the clear" and do not require set-top devices. Cable industry representatives submit, however, that traps have relatively limited applicability in an expanding cable system for a number of reasons. First, traps are a channel incremental technology, i.e., controlling more channels requires more traps. Use of more than three or four traps can result in electrical and mechanical problems. This poses difficulties for systems with many signals to protect. Traps are also not compatible with digital video compression methods because compressed digital signals carry multiple video programs on a single 6 MHz channel. Trapping a compressed channel to secure one program service would necessitate loss of access to all the multiple video programs within the 6 MHz channel. Further, traps are not practical for subscriptions that change frequently and cannot support operation of "impulse pay per view" (IPPV) and "near video on demand" (NVOD) services.[40]

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[40] Both IPPV and NVOD services are services for which charges are made on a per program basis. IPPV programs are available at set times, in much the same manner that conventional programming is presented. NVOD services, on the hand, are shown on several channels simultaneously, with staggered starting times a few minutes apart depending on how many channels are used. Thus, a viewer never has to wait more than a short time for the program to start. The NVOD approach requires considerable channel capacity, which will be provided through either expanded channel capacity or digital compression methods that allow multiple programs to be transmitted on a 6 MHz channel. Time-Warner submits that NVOD is greatly facilitated by "On Screen Displays" (OSD) and the ability to force-tune the set-top unit to a selected channel at the appropriate time. It states that without these features, subscribers have difficulty operating and understanding how to use the service. Time-Warner indicates that further improvements in these features are being developed. One would allow a subscriber to press a button to keep track of time

There are a number of additional disadvantages associated with use of traps. First, while individual traps are themselves relatively inexpensive, they are expensive to install, remove and monitor. Traps must be continuously monitored because they are vulnerable to tampering. Second, it is difficult to restrict the impact of negative traps to just one channel, and the bandwidth affected by traps increases with their operating frequency. In typical cases, the lower adjacent channels audio signal is attenuated. Securing channels in the upper frequency bands with traps, however, can cause the loss of several adjacent channels. Third, traps are sensitive to weather changes and tend to drift with age, so that a trap may no longer be effective several years after installation. Cable industry respondents indicate that the expansion of channel capacity and the availability of a great deal of choice in programming have made traps generally obsolete as the sole method of securing signals. These parties also state, however, that for many cable systems, particularly smaller systems with limited channel capacity, traps are still the preferred method of obtaining security.

The cable industry submits that addressable descrambling provides the most flexible, cost effective means of preventing signal theft while ensuring that subscribers have the opportunity to purchase the programming packages they want. Cable representatives state that scrambling can yield an excellent picture for those who purchase the signal, while hiding it effectively from those who do not. NCTA states that scrambling has two important beneficial characteristics not shared by other security approaches. First, because converter/descramblers are placed in the homes of those wishing to receive encrypted signals, scrambling allows the cable operator to pair the costs incurred in delivering the optional service with the revenues obtained.[41] Second, because a cable operator only has to install one converter/descrambler, regardless of the number of channels received, the technology is not "channel incremental."

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if an interruption occurs. When the subscriber resumes viewing, the receiver would be forced-tuned to an appropriate channel to ensure that none of the movie was missed. Time-Warner notes that the first practical implementation of this service was on its "Quantum" service in Queen's, New York. On that system, 57 channels are used for pay-per-view. The five most popular current movies are started every half-hour on four channels each, so that a subscriber is never more than a half-hour from the start of each movie. Less popular movies are started every hour or every two hours.

[41] Note that in contrast, negative traps, which eliminate signals from a cable system's line-up, must be installed everywhere except the source of revenue -- the subscribers to the protected service.