number of channels, leasing or purchasing set-top boxes, or foregoing access to the additional basic channels.

Stereophonic television sound in the home was first introduced through recorded visual media. Producing stereo sound required routing a separate sound signal from a stereo video tape recorder, or videodisk player, through a stereo sound system separate from the television. With the introduction of stereophonic sound in cable and broadcast programming, many television manufacturers began to offer stereo sound reproduction capability in the television receiver itself, eliminating the need for, although often not the use of, a separate sound reproduction system. There are even claims that some recently introduced television receivers offer "surround sound."[11]

The migration of widely demanded features like "cable ready" tuners, stereophonic sound, and videocassette recording capabilities, to television receivers is likely to continue. However, because the stock of receivers turns over more slowly than does the introduction of, or the demand for, new services, consumers who desire access to these services will continue to need, and demand, some way to obtain them.

Services that cannot be offered using many of the television receivers that consumers currently own include security control, programming guides, parental control, VCR programming, pay-per-view ordering and charging, Internet access and other two-way services, and digital services. Although some receivers being sold are capable of providing some of these services, many consumers, especially those with older sets, must use set-top boxes if they are to obtain these services.

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[11] Of course, stereo sound in receivers is not nearly as ubiquitous as the capability to tune the entire range of cable signals. Most consumers continue to purchase television receivers and audio equipment separately, in large measure because there continue to be uses for the audio equipment separate from television reception.

Some services are likely to continue to be provided only through set-top boxes because they do not command a sufficiently large market for receiver manufacturers to find it worthwhile to design the capability to receive them into their products. Other services will likely continue to require the use of set-top boxes because they require control to remain with the MVPD operator, e.g., premium services and pay-per-view. As a result, it is likely that the provision of these services will continue to require the use of devices that are external to television receivers.

III. MVPDs Must Be Permitted to Determine the Security Method Used to Protect Their Signals

MVPDs currently obtain the vast majority of their revenues from subscriber fees.[12] Because revenues come largely from subscribers, access to services must be controlled in order to protect this source of revenue against unauthorized use. This is in contrast to over-the-air television where, because industry revenues are derived almost entirely from the sale of advertising, broadcasters have no interest in restricting access to their programming by viewers.

The concern about the security of MVPD services against unauthorized use is acknowledged both in the Telecommunications Act of 1996 and in the Notice. As the legislative history of the Act makes clear, Section 629

> specifically recognizes that cable and other telecommunications system operators have a valid interest, which the Commission should continue to protect, in system or signal security and in preventing theft of service...and does not authorize the

[12] Although significant revenues are obtained from the sale of advertising, the vast majority of industry revenues are from sales to subscribers. For example, in 1995, over $21 billion in cable industry revenues came from the sale of basic and pay services while combined advertising revenues for cable systems and networks were only about $5 billion (National Cable Television Association, *Cable Television Developments*, Spring 1997, pp. 8-9).

Commission to adopt regulations which would jeopardize the security of a telecommunications system.[13]

Similarly, the Notice indicates that the Commission seeks "to adopt rules that will not conflict with the maintenance of system security nor inadvertently validate the manufacture and distribution of equipment intended for the unauthorized reception of communications services."[14]

A. Providing Security Poses Difficult Problems

The problem of MVPD security is complicated by the fact that not all subscribers receive the same services. For example, some cable subscribers take only a stripped-down basic service, using cable solely to obtain improved reception of local broadcast signals. Others purchase an expanded basic tier, but no premium services. Some subscribers take basic and a single premium service while still others subscribe to multiple premium services. Finally, there are subscribers who, in addition to the other services to which they subscribe, take pay-per-view service on an occasional basis. As MVPD systems continue to introduce information and interactive video services, the diversity among the services purchased by their subscribers will further increase as will the complexity of maintaining security.

The diversity in the array of services taken by different subscribers means that security systems used by MVPD operators must be capable of more than simply excluding non-subscribers. Security systems must also ensure that subscribers receive only the particular services for which they have paid and that they are billed correctly for those services.[15] Because of this and other

[13] Notice, Para. 4 (citing H.R. Rep. No. 104-204, 104th Cong., 1st Sess. 112 (1995)).
[14] Ibid.
[15] In contrast, security for cellular phone use concentrates on privacy and excluding unauthorized users and does not have the significant complication of accommodating users with many different service levels.

complications, theft of service is a continuing problem in the MVPD industry. For example, a 1995 NCTA survey found that overall the average percentage of basic-service theft on cable systems is 11.5% and premium-service theft is 9.2%, which at average subscription rates translates into over $5 billion in lost revenues to the cable industry.[16] As another example, after Cablevision of New York City improved its security and made pirate boxes non-functional, its subscribers were no longer able to receive the pirated services and 35 percent ordered upgrades.[17]

It should also be observed that problems of theft of premium services are not confined to the cable industry. Although retail sales of equipment, especially equipment bundled with and subsidized by service sales, have aided the diffusion of DBS services, DBS programming suppliers have not been entirely successful in maintaining the security of their systems. For example, one major DBS provider has publicly acknowledged a breakdown in security and, although it and its security system provider employed electronic counter-measures that proved somewhat successful, replacement security cards were eventually shipped to 2.4 million customers.[18]

B. The Interests of MVPDs and their Equipment Suppliers Diverge from those of Consumer Equipment Manufacturers and Retailers

The Telecommunications Act of 1996 and its legislative history make clear that the retail availability of equipment cannot be permitted to compromise the legitimate security requirements of MVPDs. As a result, whatever rules the Commission adopts to encourage retail availability must respect these needs. In this regard, the Commission must take into account the fact that the incentives of

[16] 1995 NCTA Theft of Service Survey, reported April 7, 1997.
[17] *Multichannel News*, February 24, 1997, p. 38.
[18] *Multichannel News*, February 10, 1997, p. 53, 56.

MVPDs, and the equipment manufacturers that supply them, to maintain security may diverge significantly from the incentives of retailers and the manufacturers of consumer electronics equipment.

Suppliers of equipment to MVPDs have an interest in ensuring that their security systems provide a high degree of protection against unauthorized use. If a large-scale security breach occurs, an MVPD is likely to turn to a competing supplier for future upgrades or for installations in other systems. In economic terms, system operators are repeat purchasers. Accordingly, equipment manufacturers will take into account the fact that MVPDs will not continue to purchase from suppliers with a record of offering security equipment that can easily be defeated. Similarly, although an MVPD may be discouraged from switching suppliers if the equipment supplier indemnifies the operator for the costs incurred as a result of a breach, the desire to avoid the need to make such payments gives the equipment manufacturer the incentive to take the necessary care in the same way as would the fear of losing the customer. As a result, the interests of MVPDs and those who manufacture their equipment are highly congruent, and both have the same strong incentives not to jeopardize the security of services.[19]

Retail suppliers and manufacturers of consumer equipment do not have the same strong incentives to protect MVPD security. Indeed, a poor access-control system may actually be an attractive feature to some consumers, since it allows them to receive costly services without making payments for them.[20]

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[19] For much the same reason, manufacturers of equipment for MVPDs must ensure that their licensees have the same incentives to protect operator security. Moreover, the number of firms licensed to offer security systems may have to be limited in order to protect the integrity of these systems. Finally, MVPDs may legitimately wish to limit the number and identity of wholesalers in order to weed out those who might be likely to promote piracy

[20] For example, manufacturers of "pirate" or "black" analog cable boxes remain a continuing threat to the cable industry. Recently a judgment of $25.4 million was entered against a California pirate box manufacturer that distributed between 3,000 and 5,000 boxes a year. Using NCTA's estimate of $2,500 lost revenue during the hardware's useful life, one year's activity of

Moreover, even when consumer equipment manufacturers do not affirmatively promote unauthorized use, unlike the manufacturers of MVPD security equipment and the MVPDs themselves, these manufacturers have incentives to use less expensive, and therefore less effective, security measures in order to lower production costs and obtain a competitive advantage.

The benefits of lower production costs accrue to the manufacturers and retailers of the consumer equipment, while the costs of any resulting service theft are borne by MVPDs.[21] Thus, although well known manufacturers of electronic equipment are unlikely to engage in the manufacture and sale of pirate boxes that enable theft of service, they nonetheless will not have incentives as strong as MVPD systems to protect the security of services. As a result, the issue of signal security extends far beyond "the manufacture and distribution of equipment intended for the unauthorized reception of communications services," which is identified in the Notice.

C. Embedded Security May be Required

Manufacturers of equipment used by MVPDs have developed a variety of methods for securing signals from unauthorized use. Although some cable systems use "traps" that either block a particular channel (frequency) from entering customer homes or permit reception only of the channels that have been purchased, the most common approach relies on analog scrambling techniques. The devices needed to descramble the signals are owned by the

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this single manufacturer translates into losses of up to $12.5 million to the cable industry (*Multichannel News*, March 31, 1997, p. 10). For a recent account of a large-scale piracy operation, see M. Robichaux, "Cable Pirates Sought Plunder but Blundered Into a Major FBI Sting," Wall Street Journal, May 12, 1997, p. A1, A8.

[21] Signal theft also causes harm to the owners of the intellectual property being carried since the royalties and fees paid to artists and producers by cable program services will decline if operators cannot collect for unauthorized uses.

cable system, leased to the subscriber, and placed at the subscriber's premises.[22]

With regard to analog signal descrambling, the Notice observes: "It is this descrambling circuitry that is most prone to attack by those who would obtain service without paying for it. Such techniques can be relatively easily defeated by subscribers if the necessary equipment can be purchased."[23] By not allowing consumers to own and, therefore, modify or repair the descrambling equipment, cable providers have been "using scarcity as a component of security."[24] In order to maintain this form of security, the security components must remain under the control of cable operators.[25]

The most successful security devices for analog cable systems have employed an embedded security component that cannot be removed or altered without destroying the equipment.[26] Less successful methods have used removable security elements such as "smart cards." Although it is unclear what specific security methods will be most effective for digital cable systems, it currently appears that even after cable systems have upgraded to digital signal transmission, embedded security will remain most effective.

Two factors argue for allowing market forces to determine which security method will ultimately prevail in a digital world. First, as noted above, MVPDs, and the suppliers of equipment to them, have the correct incentives to optimize the method that will be employed. Second, as discussed elsewhere in this

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[22] Some cable systems rely on addressable interdiction units that are installed outside of every home in a cable system. For example, Scientific-Atlanta introduced such devices to deliver premium, pay-per-view, and tiered services directly to subscribers with cable-ready receivers (*CableFax Daily*, Phillips Business Information, Inc., January 28, 1997, p. 1).

[23] Notice, Para. 29.

[24] Id.

[25] This does not mean, of course, that the devices are invulnerable to modification, but the fact that the cable operator rather than the subscriber owns them adds another barrier to doing so.

[26] According to General Instrument's Chairman and CEO Richard Friedland, GI's VideoCipher II Plus system has never been broken (*Business Week*, April 22, 1996, p. 131B).

paper, imposing standards in an industry where technology is changing rapidly is likely to be misguided. For both reasons, the choice of the security method used to protect digital transmissions -- in particular, whether security should be separated or embedded -- should be left to the MVPD.

IV. What Should be in a Separate "Security" Box?

The Notice suggests that a possible solution to maintaining operator control of system security while still providing for retail availability is to "require MVPDs desiring to retain control over the security equipment to provide it to consumers on a separated or unbundled basis."[27] This section addresses how best to determine the characteristics of the separate security equipment "box" that would be offered by MVPDs if this requirement were adopted. The next section examines whether operators should be able to offer integrated security-features boxes in addition to the security-only boxes that would be required under the Commission's proposal.

We observe that the ability of manufacturers to successfully separate the security and non-security features of MVPD boxes while still maintaining adequate security is still in question. In particular, it appears that the ability of MVPDs to control the entire transmission process continues to provide the highest level of security, so that requiring operators to separate security from all other functions may impair the security of a system. This is largely due to the fact that the interface between the security and non-security components is "in the open" and the ability to bypass security systems is facilitated by this open connection.

Nonetheless, MVPDs and equipment manufacturers are continuing to develop and implement new and more effective security measures, and

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[27] Notice, Para. 34.

equipment manufacturers have been pursuing an effort to separate security from other features and define an interface between them.[28] The Notice points out that:

> such an effort to separate access control from other features and migrate the functional and operational components back to the television receiver is essentially what has been involved with the "decoder interface connector" that has been the subject of discussion in the Commission's proceeding in ET Docket 93-7.[29]

There are obvious costs associated with separating security and other features. There are the purely mechanical considerations of purchasing and installing connectors and cases that may not be required for an integrated unit, but there are also the associated costs of coordinating standard interfaces and notifying equipment manufactures of network and interface modifications.[30] The separation of security and non-security elements of MVPD equipment may also require associated regulatory proceedings, such as the Commission's proceeding on the decoder interface connector. There may also be costs associated with providing information to consumers about forthcoming network modifications. Finally, when an MVPD replaces or upgrades the security or control components of its network, there may also be a need for changes in non-security components.

In light of the uncertainty about the adequacy of non-embedded security systems, and the associated costs of separating security from features, the Commission should not require MVPDs to achieve commercial availability using

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[28] The advantages of voluntary standards versus government mandated standards are discussed below.

[29] Notice, Para. 34. Whether to migrate the function and operations components back to the television receiver or to a separate piece of equipment available at retail also remains in question. The long life of major television components suggests that many services are most efficiently supplied using devices external to the television receiver, whether or not security features are provided separately.

[30] In addition, a significant portion of future cost savings for digital cable boxes may come from reducing the number of chips required. With separation of features and security, some of this VLSI integration may not be possible. Integration also increases the complexity of designing and manufacturing "pirate" set-top boxes.

such a separation model. If the Commission nonetheless does require separation, because MVPD services are provided through complicated networks, it is important to note that more than narrowly defined security may have to be under operator control. In particular, certain network control and monitoring functions will also have to remain on the security side of the "line." For example, with some types of equipment, operators can supply many types of information, including security control messages, in an out-of-band signal that may not be possible if control of that signal is relinquished. In analog systems, the vertical blanking interval is often used to transmit entitlement messages and other types of network control information. Most impulse pay-per-view systems require specific control of these non-video information streams. With the introduction of digital systems, an in-channel data stream can be used to control the set-top box from the headend and provide services that would not be possible if that control were relinquished by the operator.[31]

An additional issue is raised as MVPD systems begin to offer information services. Currently, MVPDs transmit all information to all subscribers who are authorized to receive it. In the future, individual subscribers will be receiving information that they have specifically requested. In this environment, operators must be able, as part of their security systems, to provide this information on a confidential basis. Where theft of service has directly harmed MVPD systems in the past, a lack of confidentially will harm them indirectly in the future as consumers are discouraged from taking services for which their privacy is not

[31] The Society of Cable Telecommunications Engineers (SCTE) has specified a system information standard for digital cable transmission defined to allow equipment manufacturers to build equipment that can acquire and display information about the system such as channel mapping and pay-per-view schedules. However, additional system features under the control of the cable operator will be required if a cable operator wishes to provide additional services (special formatting, system favorites, etc.) beyond those specified in the standard. See also GI's Petition for Clarification in ET Docket No. 93-7, filed on 5/28/96 (describing network control and other functions that will have to be on the "security" side of the line with the Decoder Interface).

ensured. This additional security concern will complicate the division between security and features.

This suggests that to the extent commercial availability is achieved through separation of security and features, the Commission should allow the precise boundary between security and non-security elements and, thus, the contents of the "security" box, to be determined by the on-going negotiations among MVPDs, network equipment manufacturers, manufacturers of consumer electronic equipment, and retailers.[32]

V. MVPDs Should be Permitted to Offer Integrated Boxes

There are two possible interpretations of the Commission's tentative proposal that MVPDs should be required to offer separate or unbundled security boxes. One interpretation is that the Commission is suggesting that operator-provided security equipment be offered *only* on a separated or unbundled basis, with the operator required to offer features only in a separate box. Alternatively, the Commission may be indicating that operators should be required to offer separate security equipment even if the operators choose *also* to offer equipment that combines security and features through a single box.

There are two basic reasons why, if the Commission were to require operators to offer separate security-only boxes, it should permit the operators also to offer integrated boxes. First, as noted above, there may be efficiencies, in both improved security and lower costs, from combining security and features in a single box. These efficiencies would be lost if the operator were prevented from offering integrated boxes in addition to separate security boxes.

[32] This is acknowledged in the Notice at Para. 73.

Second, if the separations model is adopted and operators are required to offer separate security-only boxes, they will have neither the incentive nor the ability to behave anti-competitively to prevent the development of a retail market for features boxes. As a result, there would be no competitive harm from permitting them also to offer integrated boxes.

As we have already observed, there are likely to be advantages, in terms of lower costs and improved security, if cable operators are permitted to offer boxes that integrate security and features. These benefits will be lost, of course, if cable operators are unable to offer boxes that combine both elements.[33] In short, there are costs if integrated boxes cannot be offered by the operator.

Moreover, there are no obvious benefits from such a ban. As long as MVPD systems provide security-only boxes, they will not be able to obtain market power in the sale of features boxes through the sale of integrated boxes.[34] In an exhaustive analysis of monopoly power and tying, Michael Whinston found that the incentives to extend monopoly power over one good into the market for another good rarely appear. Moreover, in the few cases in which such incentives are present, they can usually be limited if the putative tying product must be offered separately.[35]

Security and features boxes can generally be characterized as complements in that a reduction in the price of one will increase demand for the other. When two goods are complements and are consumed in fixed proportions, Whinston finds that "a monopolist of one component never finds it

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[33] This does not mean that there will not be a market for features-only boxes offered at retail but only that these boxes may offer (a) features that are not available through integrated boxes, (b) improved implementation of these features, or (c) the same features at lower cost. In addition, consumers may find retail distribution more convenient even if the features offered and the prices charged are the same.

[34] As discussed above, the "security-only" box offered by the MVPD will also have to contain certain network control and monitoring functions.

[35] M.D. Whinston, "Tying, Foreclosure, and Exclusion," *American Economic Review*, 80, 837-859, 1990.

worthwhile to tie in order to reduce the level of competition in the market for the other component."[36] Therefore, when the sale of a features box requires the sale of a security box, there is no incentive for an MVPD system to limit the sales of features boxes by offering integrated boxes.[37]

When features and security boxes are not used in fixed proportions,[38] if the operator offers separate security boxes and provides information that permits independent manufacturers to design features boxes that can be connected to, and interact with, these boxes, the operator cannot gain an anticompetitive advantage through the sale of integrated boxes.[39] The conclusion from this analysis is that in order to allow consumers the benefits that may come from combined security and feature boxes, MVPDs should be allowed to offer such boxes. This will not inhibit the availability of features boxes through other outlets so long as cable operators continue to offer security-only boxes and provide interface information to those who desire to make compatible features boxes.[40]

VI. Portability Should Not be Mandated

The Notice observes that:

> if a retail market for navigation equipment is to develop, it may be necessary for there to be some degree of standardization so that the devices involved are either geographically portable and will work with similar types of MVPDs in different parts of the country or

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[36] Id., p. 850.
[37] This is not to say that MVPDs will not offer integrated boxes, but only that they have no anticompetitive incentive to do so.
[38] This occurs when a subscriber does not use a security box with each features box he employs.
[39] Such requirements may be unnecessary to prevent anticompetitive behavior, but they are certainly sufficient to do so.
[40] This position has already been taken by the Commission in the Decoder Interface proceeding where it states: "...we see no need to preclude cable operators from also incorporating signal access control functions in multi-function component devices that connect to the Decoder Interface connector" (*Memorandum Opinion and Order*, ET Docket No. 93-7, adopted March 22, 1996).

> are interoperable and will function with different types of MVPDs in the same area or are both interoperable and portable.[41]

In this regard, the Notice asks:

> Is it necessary that devices simply operate with the particular MVPD's system that they are purchased for? Is it necessary that devices be operable on all MVPD's systems in the same industry -- for example, on all cable systems, or on all MMDS systems? Is it necessary that devices work for all multichannel video programming services...?[42]

The Notice then seeks comment on "the extent to which such standardization may be necessary and on the process whereby standards might be developed."[43] In this section, we address the issue of equipment portability among cable systems in different parts of the country. In the following section, we address the broader issue of equipment interoperability among different types of MVPDs.

A. Portability is Not Required for Retail Availability

Consumers can move their television receivers among areas of the U.S. and expect that they will function, whether or not they subscribe to cable services, because receivers are built to well-documented and relatively simple standards that ensure this form of portability. This degree of standardization, however, is not true of the set-top boxes used to access cable programming services. Different cable systems employ different set-top boxes purchased from different manufactures that are largely incompatible.[44] Moreover, there is no guarantee of portability of set-top boxes even where the systems are owned by

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[41] Notice, Para. 24
[42] Id.
[43] Id. Para. 64.
[44] Of course, this does not raise problems for consumers if they lease set-top boxes rather than purchase them.

the same multi-system operator,[45] or where the same manufacturer has provided equipment to different systems.

Nonetheless, portability is not required for a significant retail market to exist. DBS equipment is not portable in that equipment purchased to receive and decode signals from one provider will not work if the consumer changes to another, e.g., equipment purchased to receive Primestar signals cannot be used to receive service from DirecTV. Similarly, mobile telephones may work only with a single provider, e.g., equipment purchased for use on a Sprint Spectrum system cannot be used on, say, a Cellular One system. Thus, neither DBS nor mobile telephone equipment is "portable," in the sense that it can continue to be used if a customer changes vendors. Nonetheless, both continue to be offered primarily through traditional retail establishments. This suggests that the absence of portability of cable set-top boxes need not be an impediment to retail sales.

B. There are Benefits from Geographic Equipment Diversity

A wide variety of cable set-top boxes are currently in use. Differences among cable systems require different boxes to receive a similar *service* on different systems. Differences among consumers mean that different subscribers to the same *system* may demand different services and thus, require different boxes. There are several reasons for the current limited degree of portability of set-top boxes among cable systems.

First, a large number of equipment manufacturers compete for the patronage of cable operators by providing both a variety of technical solutions and attractive prices. For example, digital cable set-top boxes are now being

[45] This is especially true when an MSO has acquired a cable system from another operator.

offered by General Instrument, Scientific-Atlanta, Zenith Electronics Corp., and others, while licensees such as Pioneer, Toshiba, Pace Micro, and others are available as second sources.[46] The number of manufacturers is likely to continue to grow as both MVPDs and broadcasters provide more services that require such boxes.

Second, there are historical differences in the way the technologies of particular cable systems have developed, so that different cable systems may need different types of set-top boxes for their consumers, even if they are supplied by the same manufacturer. For example, systems with large channel capacities that provide a large number of basic channels and many premium service options are likely to offer different subscriber equipment than systems that offer a relatively limited array of services. Because cable systems have been free to choose the types of equipment that best meet consumer demand in their areas, some systems employ set-top boxes with limited functionality, others offer highly sophisticated equipment, and some offer both. General Instrument currently offers three different types of digital cable set-top boxes at different prices and with varying levels of functionality [47]

Third, the age and the pace at which upgrades have occurred varies among systems. As a result, equipment on newer systems, or systems that have recently been rebuilt, is likely to differ from that offered by older systems. Because individual systems have been built or upgraded at different times, there are variations in the "vintages," and hence the functionality, of equipment being used even when purchases are made from the same manufacturer.

Consumers have benefited from the ability of cable operators to tailor their equipment to the demands of their subscribers and to the particular

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[46] *Multichannel News*, March 17, 1997, p. 122.
[47] *Cable World*, March 17, 1997, p. 152.

characteristics of their systems. Consumers also benefit when new equipment can be installed on a particular system without this installation having to take place on all systems owned by the operator or on all cable systems nationwide.[48] For example, digital set-top boxes initially incorporated 64 QAM modulation while new boxes are being introduced that incorporate both 64 QAM and 256 QAM. Consumers on systems with later upgrades can enjoy the additional benefits of 256 QAM boxes which allow for transmitting up to 6 additional digital video services per multiplexed channel.

The absence of national standards for cable transmission and subscriber equipment has also allowed cable systems to experiment with new equipment, features, and services. Equipment that facilitates the use of a particular service can be introduced into a single cable system in order to test consumer response to the service. With national standards and mandated equipment portability, this opportunity for experimentation and testing may be lost.

Moreover, due to variations in consumer demand among cable systems, the imposition of a single standard will result in some subscribers paying for equipment that is more sophisticated than they need while others will be unable to obtain services for which they are willing to pay because the standardized equipment does not support the services. Alternatively, a cable operator may offer equipment capable of receiving the more extensive array of services, assuming it is technically feasible to do so, as a higher-cost option.

Mandating equipment portability will likely increase equipment costs. As the Notice points out, "In general, costs are directly increased as the scope of interoperability and portability are widened."[49] A recent article cites an unnamed

[48] The sales of advanced analog cable converters are quickly overtaking those of standard analog converters, but have not displaced them (*Cable TV Technology,* Paul Kagan Associates, March 26, 1997, p. 3). This is an example of a new technology slowly displacing an existing one without having to be introduced nationally at one time.

[49] Notice, Para. 65.

cable system executive as quoting the following prices for options on General Instrument digital cable set-top converters:

- Bit-mapped graphics for enhanced display, $10;
- Analog descrambler, $20;
- Stereo decoder, $18;
- Additional megabyte of memory for b-frame decoding, $20;
- Telephone return module, $20;
- RF bypass module $9.50;
- Audio loop through, $5;
- High-power blaster port for automatic VCR programming, $4;
- Infrared blaster module, $10;
- Universal remote control, $17.[50]

Any, or all, of these "options" could conceivably be required as standard for portability, although they are not supported by some cable systems. This would force some consumers to purchase options that they are not able to use and substantially increase the cost of equipment.[51] Mandating portability may also require significant equipment changes at the cable system headend since headend equipment obtained from a particular manufacturer is not necessarily interoperable with set-top boxes obtained from another. As a result, the costs of the transition to portability may be large.

Developing, implementing, maintaining, and monitoring cable transmission and equipment standards will be costly. In order to minimize the effects on innovation and system differentiation, the cable industry should be allowed to continue to define its own standards for transmission and consumer equipment. Government intervention in this standard-setting process may severely restrict the cable industry's effectiveness and raise its costs. Moreover, as shown by the example of cable modems, cable operators may benefit from,

[50] *Multichannel News*, August 19, 1996, p. 2.
[51] Webbink, op. cit., provides evidence that the requirement of UHF-capability in all new receivers imposed significant costs on consumers because few consumers were in the range of even a single UHF broadcaster.

and therefore, encourage equipment portability when it reduces the cost of equipment purchased by the industry and improves the services it can offer. [52]

VII. Interoperability Should Not be Mandated

Significant additional technical complications are added when interoperability is required for consumer equipment. Not only must equipment operate with different cable systems, but it must also operate with other MVPDs that currently use significantly different mechanisms to transmit video.

Television receivers can receive signals from MVPDs using widely varying transmission methods through the use of external converters. These convert the incoming multichannel signal into a single RF transmission that is then provided as output to the television or, with newer receivers and converters, a baseband video signal can be sent directly from the converter to the television receiver.[53]

The level of interoperability that is mandated will significantly affect the cost of its implementation. Completely interoperable equipment would need connectors that allow it to be attached to at least a DBS satellite receiver, an MMDS receiver, a cable receiver, a broadcast receiver, a SMATV receiver, and a baseband video signal. These connectors would then allow the consumer to select a particular video signal from any of those sources. It is unclear whether this goal is technically feasible and exactly where the connections would be for each of the paths of those signals.

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[52] CableLabs released the MCNS Radio Frequency specification for cable modems on March 16, 1997. Eighteen vendors initially agreed to comply with the specifications including General Instrument, 3Com, Bay Networks, Scientific-Atlanta, and Motorola (*CableFax Daily*, Phillips Business Information, Inc., March 18, 1997, p. 1.)

[53] Many receivers that are currently sold include baseband video inputs while VCRs, video game players, and many cable boxes include a baseband video output. This eliminates the need for the output source to remodulate the video signal to a particular RF channel and have the television receiver convert the RF signal back into baseband video.

Consumers who subscribe to and remain with only one service provider will see little benefit from interoperability but will still have to bear the costs if interoperability is mandated. Moreover, the costs of interoperable set-top boxes may exceed the benefits even for those consumers who change from, say, cable to DBS. Nonetheless, some types of interoperable equipment are being introduced. For example, Swedish companies Telia and Ellemtel are testing multimedia set-top boxes to provide video-on-demand via ADSL telephone lines, Internet, satellite, and cable.[54] As a result, consumers who wish to maintain the option of changing their type of service provider without changing their equipment may be able to do so even without mandated interoperability.

VIII. Below-cost Equipment Pricing May Overcome Excess Inertia

It has been recognized for some time that the adoption of new technologies in network industries poses special problems. In particular, when the value that users place on a product depends not only on its intrinsic characteristics but also on the number of other users, i.e., when there are network externalities, adoption decisions are affected by the number of those who have already purchased the product or by expectations about how many others will eventually do so.[55] Consumers may initially be reluctant to purchase such products even when they have great intrinsic value because they fear that the products may eventually attract only a small number of users, as in the case of quadraphonic sound, or because they are unsure which version will prevail in the contest to become an industry standard, as in the case of the competing

[54] *Communications Daily*, February 27, 1997, p. 3.
[55] The classic example is the telephone industry. Telephone service to one user has no value, while the value to any one user increases as the number of other users grows.

videocassette recorder standards. In both cases, purchasers may obtain payoffs that are too small to justify their initial investment.[56]

In these circumstances, each user may rationally choose to "wait and see" what choices others make before making their own. However, if a large number of potential adopters take this approach, the new technology may never be adopted even if everyone would benefit if it were. This phenomenon has been labeled excess inertia.[57]

The problem of excess inertia arises because of difficulties in coordination among potential users. If all users would be better off if everyone adopted the new technology, and they can communicate this fact to one another, they may be able to agree that all will adopt the new technology, thus, vindicating their individual purchases. Coordination, however, may be difficult, especially when the number of users is large and adoptions occur over a long period of time,[58] so that some other mechanism may be needed to encourage adoption.[59]

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[56] In the second case, purchasers can switch to the successful version, but they experience costs in doing so.

[57] J. Farrell and G. Saloner, "Standardization, Compatibility, and Innovation," *Rand Journal of Economics*, 16, 70-83, 1985. In network industries, the opposite phenomenon is also possible. Some users may choose a new technology because they benefit from doing so, thus forcing others to follow although the latter are worse off than if the new technology had never been adopted. Moreover, this can occur even if the losses to the "followers" exceed the gains to the "leaders." This phenomenon has been labeled excess momentum by Farrell and Saloner, "Installed Base and Compatibility: Innovation, Product Preannouncements, and Predation," *American Economic Review*, 76, 940-955, 1986, and insufficient friction by Katz and Shapiro, "Product Introduction with Network Externalities," *Journal of Industrial Economics*, 40, 55-83, 1992.

[58] The same factors also create difficulties for using side payments among adopters.

[59] To be clear, we are not claiming that these mechanisms are always needed. The intrinsic value to early adopters may be sufficiently great that they would choose to adopt the new technology even if others do not, and others may then follow. In this case, the network of early adopters is sufficiently large for there to be net benefits for those who adopt early whether or not others also adopt later.

Although some novel methods have been suggested for overcoming inertia,[60] the approach most often discussed is offering lower prices to early adopters. Early adopters generate benefits for later ones, because their purchases lead to the growth of the network, which increases the value of the product to all adopters. However, early adopters do not take these external benefits into account in their adoption decisions. As a result, adoptions may occur too slowly, or not at all. If prices to early adopters are reduced, however, their decisions will more closely reflect the combined benefits to themselves and later consumers.

The sponsor of a technology is the natural entity to offer below-cost pricing if it can capture a large share of the benefits that result from the growth of the network. David notes that:

> A firm which is convinced that the system whose benefits it can internalize will be superior in the future to the existing incumbent system, may find it worthwhile to subsidize the initial adoption of its system by 'penetration pricing' (below cost).[61]

Katz and Shapiro, on whose analysis David draws, observe that:

> If a single firm controls the property rights to a given technology or if there are other entry barriers into the supply of that technology, then a supplier will be willing to make investments in the form of penetration pricing to establish the technology because such investments can later be recouped by pricing in excess of marginal costs....Sponsorship can internalize some of the externalities through below-cost pricing at the beginning of a technology's life.[62]

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[60] For example, P.H. Dybvig and C.S. Spatt, "Adoption Externalities as Public Goods," *Journal of Public Economics*, 20, 231-247, 1983, propose that early adopters be guaranteed that the product will be repurchased if large numbers of others do not also purchase the product. Where everyone prefers the new technology, each user will choose to adopt because there are no costs of stranding, and the guarantee never needs to be exercised.

[61] P.A. David, "Some new standards for the economics of standardization in the information age," in P. Dasgupta and P. Stoneman (editors), *Economic Policy and Technological Performance*, Cambridge: Cambridge University Press, 1987, p. 227.

[62] M.L. Katz and C. Shapiro, "Technology Adoption in the Presence of Network Externalities," *Journal of Political Economy*, 94, 822-841, 1986, p. 825. Katz and Shapiro note, however, that

Similarly, Rohlfs considers a communications service that:

> ...even though viable, cannot get started by itself. It requires some positive action by the seller, probably involving temporary losses.... The most direct approach is to give the service free to a selected group of people for a limited time. For this method to succeed, the initial user set must, of course, be sufficiently large to achieve critical mass.... Another way to start up the service is to have a low introductory price. This price could then be raised as the number of subscribers increased.[63]

The implication of this analysis is that promoting the widespread adoption of new technologies where there are important network externalities may require that early adopters be offered lower prices than later ones. That is, it may be literally impossible for a new network technology to succeed without the impetus provided by the purchases of early adopters. In any event, the diffusion of the technology may proceed quite slowly unless prices are initially set below cost.

In the present case, MVPD subscribers may be reluctant to purchase new set-top boxes in order to purchase new services because they fear being "stranded" with a box that is not widely used. If the box is not widely adopted, all of the new services for which the boxes have been purchased may not become available and the benefits from the purchase may be insufficient to justify its cost. Lowering prices to early adopters provides a way to overcome their reluctance to purchase the boxes by reducing the magnitude of the investment they must make.[64]

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sponsorship is not an unmixed blessing and can lead to "excessive standardization or standardization on the wrong technology."

[63] J. Rohlfs, "A Theory of Interdependent Demand for a Communications Service," *Bell Journal of Economics and Management Science*, 5, 16-37, 1974, pp. 32-34.

[64] Even when boxes are leased, so that stranding is not an issue, MVPDs may have to lower the lease price to overcome the fact that the full range of services for which the boxes are to be used may not initially be available to early adopters. It should also be observed here that MVPDs can offer incentives to retailers to lower their equipment prices and that some DBS operators have already chosen to do so.

Below-cost pricing may also be necessary for early adopters if there are significant learning-curve effects in the production of set-top boxes. If only a few boxes are built and sold, the average cost per box may be quite high, even if the average cost of production declines sharply as cumulative production increases. For this reason, the sponsor of a new technology has an incentive to set prices to early adopters below the costs of production and to set prices to later adopters above the cost of serving them.[65] Here, the external benefits generated by the purchases made by early adopters take the form of reduced production costs from which later adopters benefit.

The benefits from setting below-cost prices to early purchasers and recouping the resulting shortfall through higher margins on later purchasers can make all consumers better off. Early adopters pay a lower price than they otherwise would, and later adopters are able to purchase a product that otherwise would not be available.

IX. Lower Equipment Prices May Promote the Sale of Services

In the previous discussion, it was assumed that, after the initial period of below-cost promotional pricing, the margin between price and cost would be raised for later adopters. Indeed, the sales at higher prices to later adopters was assumed to be required to compensate the sponsor for the losses incurred during the period when prices were set below cost. However, there is a second reason for setting low prices for equipment in which the low prices may persist.

Suppose that the product in question is one of a pair of products that must be used together to provide a service, i.e., the products are complements. For example, suppose that the products are set-top boxes and communications

[65] Note that there is no inconsistency between this analysis and the observation that prices tend to decline over time. The point is that prices generally decline more slowly than costs.

services. In this case, reducing the price of one product increases the demand not only for that product but also for the other. That is, lower prices for equipment will not only induce additional consumers to purchase equipment but, because equipment is used to provide services, it will also induce those consumers to purchase services as well. As a result, the entity that sells the services may have an incentive to charge a permanently lower, perhaps below-cost, price for equipment, an incentive that does not exist for firms that sell only equipment.[66]

In the present context, the implication of this analysis is that MVPDs alone have the incentives to lower the price of equipment, including the prices of set-top boxes, because their subscribers will then use these boxes to purchase services that are also sold by the operator.[67] Consumer electronics equipment manufacturers and the retail establishments that sell such equipment do not have these incentives because their revenues flow entirely from equipment sales, and they obtain no revenues from the sale of services.[68] Significantly, unlike the case of promotional pricing to overcome excess inertia, this low, possibly below-cost, pricing may persist even after the network has become established because the operator wants to induce additional users to take the new services and may have to charge low prices for equipment in order to encourage them to do so.

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[66] There is the associated problem that consumers do not want to purchase boxes until services are offered, while MVPD systems do not want to offer services unless consumers have the equipment to receive them. This problem can be solved if an MVPD system can simultaneously offer both services and boxes.

[67] There are many examples of this form of pricing, including many drawn from the telecommunications industry. For example, cellular companies offer free or below-cost handsets to consumers who sign up for their communications services, and DBS operators subsidize the purchase of the reception equipment needed by their subscribers. This is pointed out in the Notice at para. 43.

[68] Although the cellular and DBS equipment purchased at consumer electronics stores may be subsidized, the source of the subsidy is the service provider, not the equipment manufacturer or the retailer.