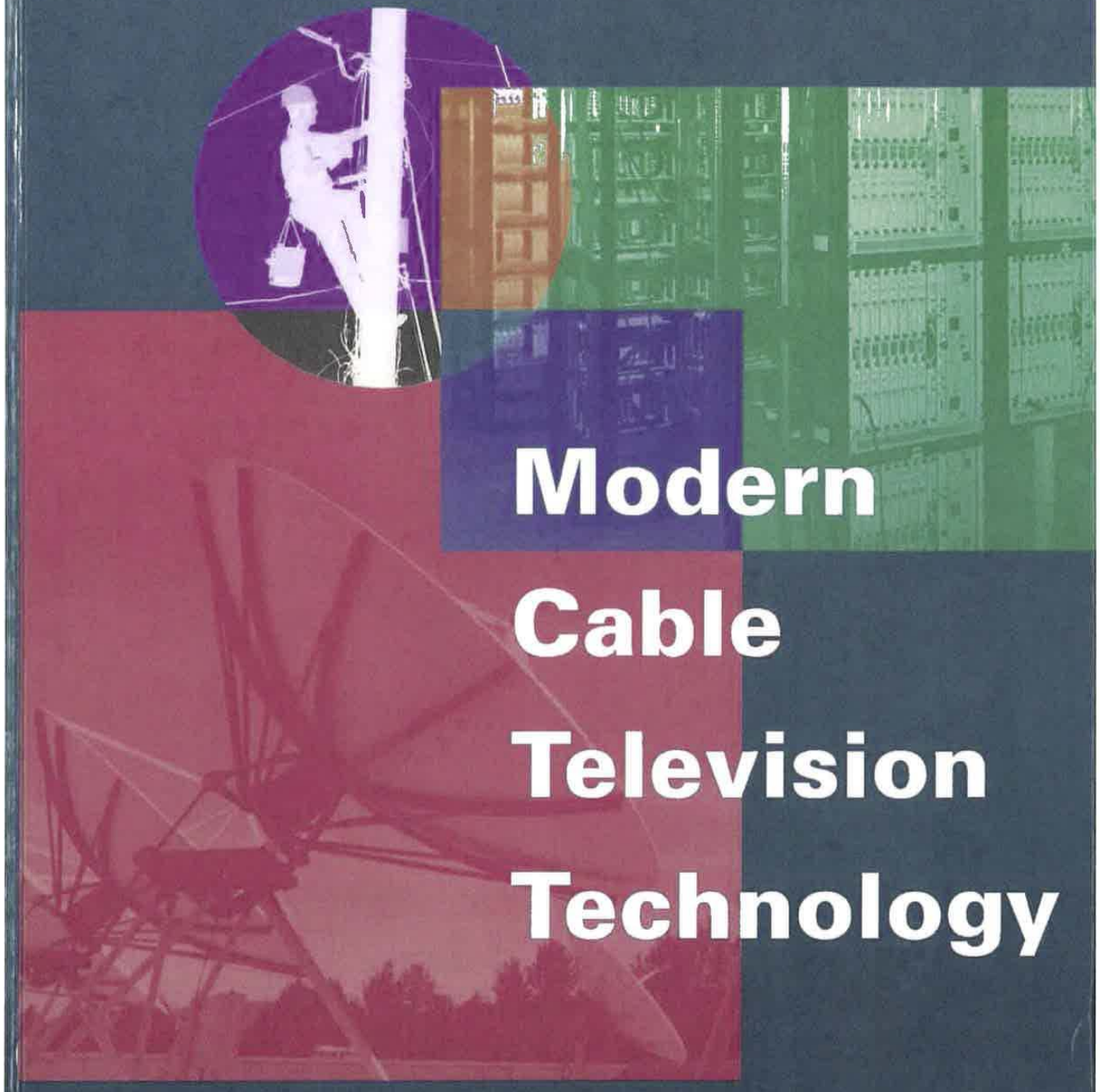
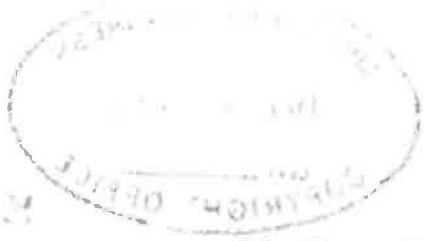
Walter Ciciora | James Farmer | David Large



Modern Cable Television Technology

Video, Voice, and Data Communications



Modern Cable Television Technology

Video, Voice, and Data Communications

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Chapter 19

Consumer Electronics Interface

19.1 Introduction

Cable services are enjoyed via the subscriber's consumer electronics products, the most important of which are television receivers and videocassette recorders. Stereo and surround-sound systems are also important to home theater installations. Coordinating the use of all the features of these products with cable services causes complications. Add-on devices such as video games, Web appliances, digital video disc (DVD) players, personal computers, home security and control systems, and other consumer electronics products add still more challenges. The cable–consumer electronics interface issues are complex, and satisfactory solutions have been elusive even with extensive committee work and cooperation between the industries. This chapter will survey the issues and some of the attempts to alleviate the problem.

There are two principal aspects to the issues concerning the interface between consumer electronics products and cable systems. One aspect is the way in which this interface affects the usage of cable services and of consumer electronics products and their features. The other aspect involves matters of law and politics. Both aspects will be considered, but separately.

Five major constituents have interests in these issues: (1) the subscriber/consumer, (2) the service provider, (3) the service provider's equipment manufacturer, (4) the consumer electronics and related industries, and (5) government agencies creating laws and rules related to these issues.

19.2 The Nature of the Interface

19.2.1 Cable Services

For purposes of this discussion, cable services can be categorized as (1) basic, (2) expanded basic, (3) pay, (4) pay per view, and (5) other.

Basic services are not scrambled as a matter of law. This is a requirement of the 1992 Cable Act, which we discuss later. Signal delivery is accomplished merely by connection—usually by a technician physically connecting the drop cable to the cable plant. In a few cases, a switched tap is used to connect the subscriber under electronic control without the need for a technician to visit the tap location. Signal denial for those who no longer subscribe is done by disconnecting the subscriber from the cable plant. The subscriber who takes only the basic service and has a consumer electronics product that can tune all the channels of interest experiences the same amount of complexity as found when connected to an antenna.[1]

A converter with appropriate tuning capability is used in situations where (1) the subscriber's consumer electronics product does not tune all the channels of interest, (2) the product suffers from inadequate tuner performance, or (3) the product does not include remote control and the subscriber desires that feature. A converter is an extended capability tuner with a channel 3 or 4 output. It usually

also includes a remote control. Converters were once commonly leased by cable operators. That is much less common today because converters are rarely needed since few very old receivers are still in service. Converters are available at retail.

Expanded basic services involve additional channels and an additional price. Signal denial for nonsubscribers is usually accomplished by traps or, less commonly, by scrambling. Alternative signal denial possibilities include interdiction and broadband descrambling. These alternatives have not found wide acceptance. All these technologies are described in the previous chapter. When traps, interdiction, or broadband descrambling is used, the subscriber experiences the same amount of complexity as found when the TV and VCR are merely connected to an antenna in the usual way recommended by the TV and VCR manufacturers. This assumes that the consumer electronics products tune all the channels of interest; otherwise, a converter is required.

Pay services, also called premium services, are sold by the month on a channel-by-channel basis. Pay services feature movies and special events and require a substantial additional fee. Signal denial for nonsubscribers is usually accomplished with traps for services with stable acceptance, that is, that have subscribers who keep their subscriptions for extended periods. There are two major types of traps: negative and positive. Negative traps allow subscribers to the premium service to receive it "in the clear" without any signal processing. With this technique, basic subscribers who do not take popular pay services have the negative trap installed in their connection to the cable system. The negative trap filters out the channel that is not taken. Popular services are those where more than half of basic subscribers take the service. Positive traps are installed at premium service subscriber locations when less than half of the basic subscribers take the service. A factor in making the choice between positive traps and negative traps is the need to minimize the number of units required. Alternative signal denial methods include interdiction and broadband descrambling. Conventional descrambling is used for services with higher rates of turnover or where additional security is desired. When traps, interdiction, or broadband descrambling is used, the subscriber experiences the same amount of complexity as when the TV and VCR are connected to an antenna (assuming the consumer electronics products tune all the channels of interest).

Pay-per-view services are sold one at a time and almost always utilize an addressable descrambler. In the past, disposable traps that timed-out after the pay-per-view event were used, but with only moderate success.

Other services are generally taken by more sophisticated subscribers who have little or no difficulty with the interface between their equipment and the cable system.

19.2.2 Relevant Cable Set Top Terminal Features

Cable set top terminals have a couple of important features that have been designed specifically to help with the interface between cable systems and consumer electronics products.[2]

The *auto bypass switch* is a feature that bypasses the entire cable spectrum to the TV (or VCR) when the set top terminal is turned off. This is an option that either is built into set top terminals or is available as an add-on. It is intended to allow the TV's (or VCR's) remote control to operate the TV's (or VCR's) tuner when the set top terminal is not used for scrambled channels. Though the auto bypass switch was available before the 1992 Cable Act's Consumer Electronics Interface amendment, the act motivated wider availability of the feature. Cable operators are required to make these switches available to subscribers but are allowed to charge for their costs. This feature has had little consumer demand.

The *dual descrambler* feature puts two tuners and descramblers in one package so that subscribers are not limited to unscrambled channels for some of the modes of operation of consumer electronics products. Cable operators are required to make these units available to subscribers and are allowed to charge for their costs. This feature also has had very little consumer demand.

The cable industry and independent entrepreneurs have developed a number of switching appliances to facilitate configuration of the interconnections for various purposes. Other devices intended to ameliorate these difficulties have been offered for sale. None of them has found long-lasting marketplace acceptance.

19.2.3 Relevant Consumer Electronics Characteristics and Features

TVs and VCRs are the primary consumer electronics equipment affected by cable service. These products come with a wide variety of features. The most important features for these issues relate to the remote control and the tuner. The remote control is used to turn the device on and off, change channels, and operate other features. Another feature of the VCR is its timer, which is used to commence and terminate recording and to change channels at appropriate times to capture programs of interest. Other TV and VCR features of interest include parental control, last channel tuning, sleep timers, and favorite channel access.[3]

Premium TV receivers include a feature called *picture-in-picture,* (PIP), which allows a small picture to be inserted into the large picture. Most often, the signal for the second picture comes from another source such as the tuner in a VCR or a television camera that might be placed in a baby's room or at the door to monitor visitors. Often the two signals may be interchanged with the press of a button. Another variation of the PIP feature includes the scanning of the channels with the capture of a set of miniature still frames providing a glimpse of what is on the various channels.

Most modern television receivers and VCRs have a feature, called *auto channel setup,* that automatically searches for available channels when the unit is first plugged in (and after every extensive power outage). The TV or VCR takes several minutes to search all the channels it can tune and loads into memory those that contain programming. Many (but not all) of these receivers will skip over most scrambled channels. When the viewer uses the channel up or down button, these channels will be skipped.

The *antenna and cable/converter switch* feature (usually operated by remote control) switches between two or more inputs to the TV. One input is intended to be from the converter and the other directly from the cable (or an antenna). The intention here is to allow the TV's tuner to do the work when nonscrambled channels are watched and just use the converter/descrambler's tuner when scrambled channels are watched. This feature is similar in function and purpose to the auto bypass switch option in converter/descramblers.

The *TV/VCR switch* feature on a VCR determines whether the entire cable spectrum is presented to the TV or just the channel tuned by the VCR or the tape playback.

19.2.4 Consumer Frustration

The two principal aspects of consumer frustration are the installation and the utilization of consumer electronics products with cable services. Both of these frustrations come from the variety of services and features found in these products.

19.3 Connecting Cable, TVs, VCRs, and Set Top Terminals

In 1987, the NCTA Engineering Committee formed a Subcommittee on Consumer Interconnection and developed a set of 27 diagrams indicating the most likely methods of connecting a TV, VCR, and one or more set top terminals along with an assortment of switches and signal splitters. Many of these diagrams are also found in consumer's manuals that come with new TVs and VCRs. All the interconnection schemes have advantages and disadvantages. None solves all of the problems. Reviewing some of these diagrams results in a better understanding of the complexity of the problem.[4]

19.3.1 Basic Cable and Trapped Premium Service Connection

Figure 19.1 is illustration 12 of the NCTA connection diagram set. The cable is connected to the VCR, which is connected to the TV. This diagram is for the basic-service-only subscriber and the subscriber who has premium services controlled by traps. No set top terminal is used. Since less than half of cable subscribers have set top terminals and since most subscribers connect more than one TV or VCR to cable, the majority of cable connections use this simple configuration.

Advantages

1. Least expensive.
2. TV and VCR operate as with antenna connections.

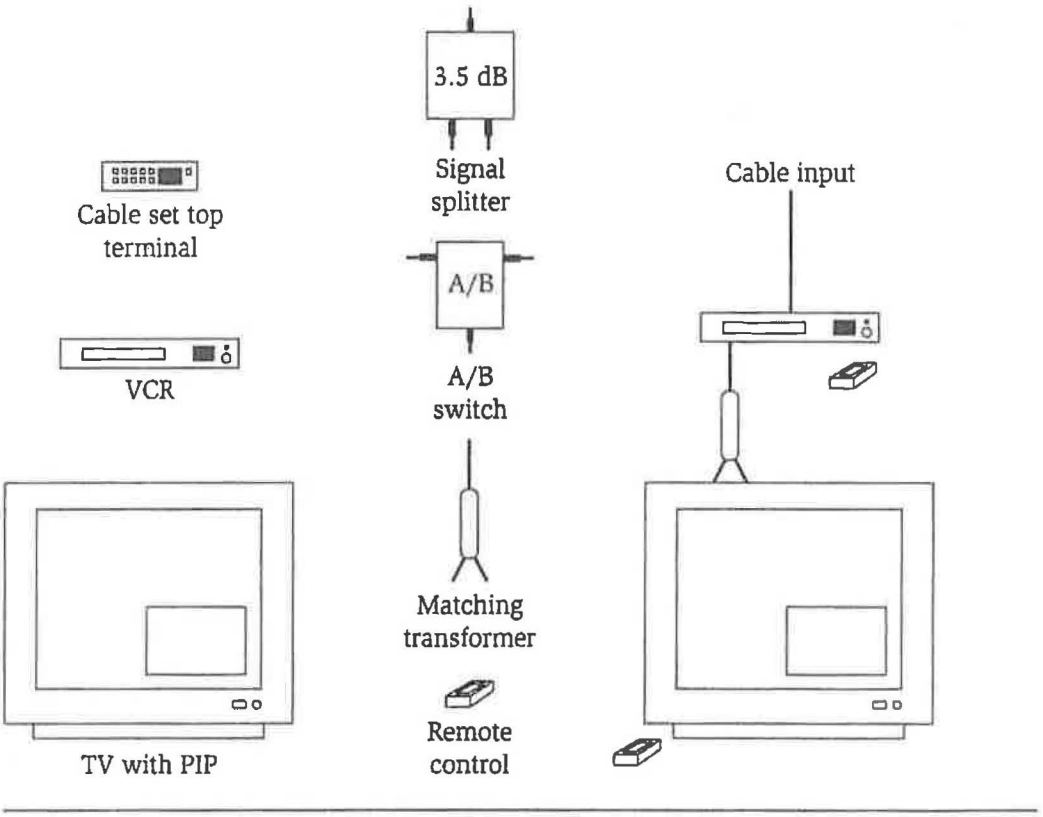


Figure 19.1 In-home equipment and simplest connection without set top terminal.

3. Can consecutively record different unscrambled channels automatically.
4. Can watch one unscrambled channel while recording a different unscrambled channel.
5. PIP works with unscrambled channels when VCR's baseband output is connected to TV's baseband input.

Disadvantages

1. No scrambled services available for either watching or recording.
2. No interactive services available.
3. Have to remember to put TV to channel 3 when watching recorded tapes.
4. Need to use two remote controls or a "universal" remote control.
5. TV's parental control is inoperative when using VCR's tuner.
6. Consumer's tuner subject to overload and damage from lightning strikes on cable.
7. Signal leakage possible from inadequately shielded tuners.

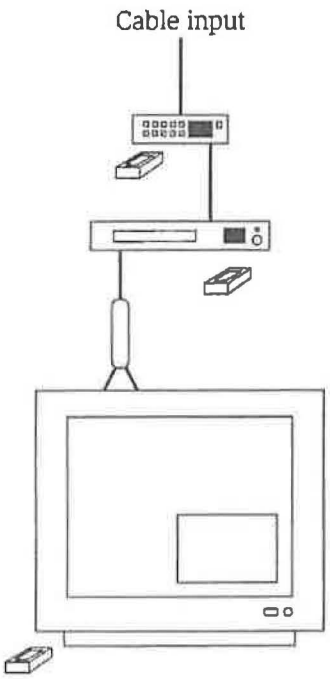


Figure 19.2 Most common cable connection with set top terminal.

19.3.2 A Simple Start

Figure 19.2 is illustration 1 of the NCTA connection diagram set. The cable is connected to the set top terminal, which is connected to the VCR, which is connected to the TV. This is by far the most popular connection method involving a set top terminal because it is the least expensive and simplest to implement and use.

Advantages

1. Inexpensive and easy to install.
2. Easy to understand.
3. Can record scrambled channels.

Disadvantages

1. Can't watch one channel and record a different channel.
2. Can't consecutively tape different channels automatically because VCR tuner does not do channel selection.
3. Neither the TV tuner nor the VCR tuner has any control.
   (a) TV's parental control, favorite channels, and last channel recall features are inoperative. The TV is just tuned to channel 3 (or 4).

(b) VCR's timer, parental control, favorite channels, and last channel recall features are inoperative. The VCR is just tuned to channel 3 (or 4).

4. Need to use three remote controls or a universal remote control to turn on the three devices and put the TV and VCR to channel 3 (or 4).
5. Makes the TV's picture-in-picture feature useless.

Special Case

1. If the converter/descrambler has an auto bypass switch, then when the converter is turned off, the entire cable spectrum passes through to the VCR, and the situation is exactly the same as in Figure 19.1, which is the case where no set top terminal is used. When again using a scrambled channel, the subscriber must remember to put the VCR to channel 3 (or 4). If the set top terminal has the channel-mapping feature and the TV or VCR does not, the same programming may appear on two different channel numbers. One channel number will be found on the set top terminal and the other on the TV or VCR. This may be confusing.

19.3.3 Two Set Top Terminal Case

Figure 19.3 is illustration 2 of the NCTA connection diagram set. The cable signal is split and connected to two set top terminals. The left set top terminal is connected to a VCR, which is connected to one input of an A/B switch, which is connected to the TV. The right set top terminal is connected to the other input of the A/B switch.

This is one of the least popular installations because of its expense and complexity. It would be used by "techies" who want the most flexible system and can both visualize how it works and handle multiple remotes with ease. It will be very frustrating to others. The dual descrambler feature could be used to simplify both the installation and operation of this connection. On-screen displays could further assist the subscriber. Despite the flexibility of this connection and the potential to make it relatively easy to use with on-screen displays, its usage is very limited.

Advantages

1. Most flexible.
2. Can watch any authorized scrambled or unscrambled program.
3. Can record any (other or same) authorized scrambled or unscrambled program.
4. PIP can be used with both channels if the TV has baseband inputs that are connected to the VCR's baseband outputs.
5. Useful in systems that have both analog scrambling and digital television.

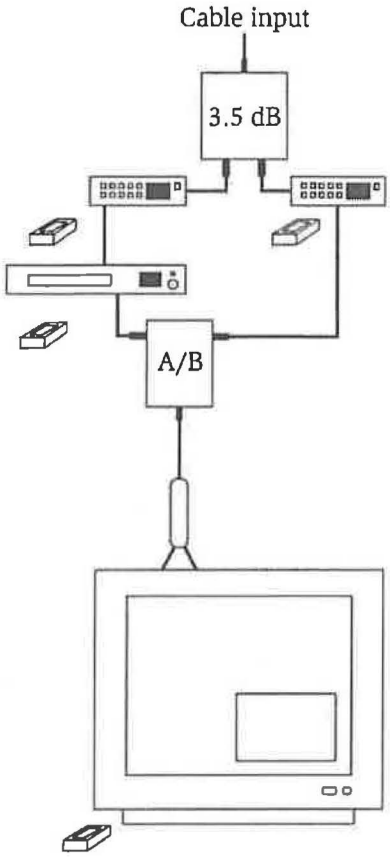


Figure 19.3 Connection with two set top terminals.

Disadvantages

1. Can't consecutively tape different channels automatically because VCR tuner does not do channel selection.
2. Expensive hardware and monthly fees.
3. Complex to install, many cables, many opportunities for signal leakage.
4. Complex to operate; need to use at least three remote controls.
5. Neither the TV tuner nor the VCR tuner has any control.
   (a) TV's parental control, favorite channels, and last channel recall features are inoperative. The TV is just tuned to channel 3 (or 4).
   (b) VCR's timer, parental control, favorite channels, and last channel recall features are inoperative. The VCR is just tuned to channel 3 (or 4).
6. Need to use three of four remote controls or a universal remote control.
7. Most brands of set top terminals will operate simultaneously from one remote control. Consequently, the subscriber may have to operate one terminal

as manual. If the set top terminal supports two control codes, four remote controls may be used with this configuration.

8. If both analog scrambled and digital channels are being used, may need to interchange set top terminals depending on which is to be recorded and which is to be watched.
9. Switch at TV is usually manual, requiring getting out of the chair unless the switch is built into the TV and remote controllable.
10. Splitter cuts signal in half and may introduce noticeable noise.

Special Cases

1. If the left converter/descrambler has an auto bypass switch, then when the converter is turned off, the entire cable spectrum passes through to the VCR, and the situation is exactly the same as in Figure 19.1.
2. If the right converter/descrambler has an auto bypass switch, then when the converter is turned off, the entire cable spectrum passes through to the TV, and the situation is similar to that shown in Figure 19.1 but without the VCR.
3. If the set top terminal has the channel-mapping feature and the TV or VCR does not, the same programming may appear on two different channel numbers. One channel number will be found on the set top terminal and the other on the TV or VCR. This may be confusing.

19.3.4 Minimal Scrambled Channel Usage

Figure 19.4 is illustration 5 of the NCTA connection diagram set. The cable signal is split into two paths. The left path is connected to a set top terminal, which is connected to an A/B switch, which is connected to a TV. The right path is connected to a VCR, which is connected to the other input of the A/B switch.

This connection could be used by someone who wishes to continue the use of the features of their TV and VCR as enjoyed before cable, and only occasionally watches, but never records, scrambled channels. This is especially convenient for someone with only one scrambled channel or who uses the converter/descrambler only for pay per view but doesn't record that programming. The right-hand path is identical to Figure 19.1. Alternatively, since the path with the converter can be used to watch either scrambled or unscrambled channels, the only purpose for the switch is to watch recorded tapes. That could also be accomplished with the VCR's baseband output and the TV's baseband input.

Advantages

1. Easy to use if most of the usage is for unscrambled channels.
2. Can watch any channel while recording any unscrambled channel.
3. Can consecutively record unscrambled channels automatically.

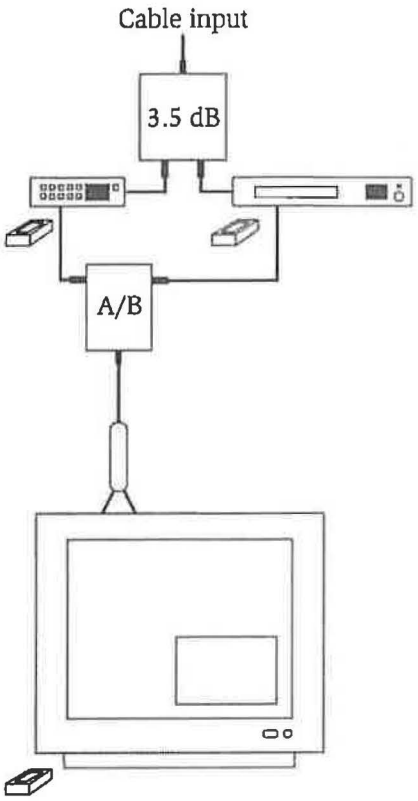


Figure 19.4 Connection for few scrambled channels.

4. Especially easy if only one scrambled channel is taken.
5. PIP can be made to work as long as the second picture is unscrambled.

Disadvantages

1. Can't record scrambled channels.
2. On the left side, TV's parental control, favorite channels, and last channel recall features are inoperative. The TV is just tuned to channel 3 (or 4).
3. Switch must be manually operated unless it is built into the TV.
4. Need to use three remote controls or a universal remote control.
5. Splitter cuts signal in half and may introduce noticeable noise.

Special Cases

1. If the converter/descrambler has an auto bypass switch, then when the converter is turned off, the entire cable spectrum passes through to the

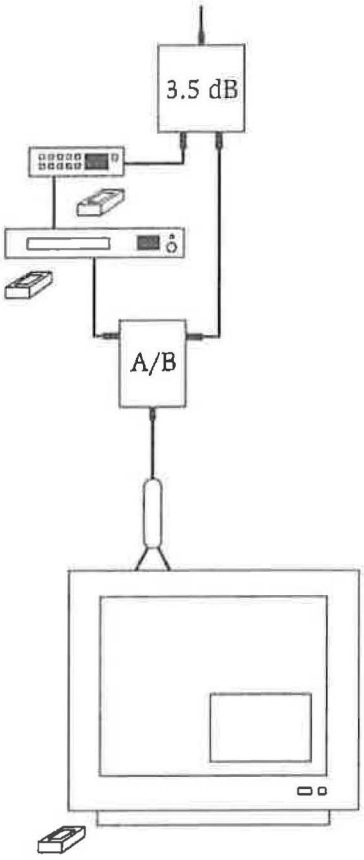


Figure 19.5 Modified most common connection.

TV, and the situation is similar to that shown in Figure 19.1 but without the VCR.

2. If the set top terminal has the channel-mapping feature and the TV or VCR does not, the same programming may appear on two different channel numbers. One channel number will be found on the set top terminal and the other on the TV or VCR. This may be confusing.

19.3.5 Improved Simple Connection

Figure 19.5 is illustration 4 of the NCTA connection diagram set. This configuration inexpensively overcomes some of the difficulties of Figure 19.2 and especially makes sense if the TV has a built-in A/B switch.

Advantages

1. Inexpensive and easy to install.

2. Easy to understand.
3. Can record scrambled channels.
4. PIP feature can be used when one of the channels is always unscrambled and the VCR's baseband output is connected to TV's baseband input.

Disadvantages

1. Can't consecutively tape different channels automatically because VCR tuner does not do channel selection.
2. Need to use three remote controls or a universal remote control.
3. On the left side, neither the TV tuner nor the VCR tuner has any control.
   (a) TV's parental control, favorite channels, and last channel recall features are inoperative. The TV is just tuned to channel 3 (or 4).
   (b) VCR's timer, parental control, favorite channels, and last channel recall features are inoperative. The VCR is just tuned to channel 3 (or 4).
4. Switch at TV is usually manual, requiring getting out of the chair unless the switch is built into the TV and remote controllable.
5. Splitter cuts signal in half and may introduce noticeable noise.

Special Cases

1. If the converter/descrambler has an auto bypass switch, then when the converter is turned off, the entire cable spectrum passes through to the VCR, and the situation on the left side is exactly the same as in Figure 19.1.
2. If the set top terminal has the channel-mapping feature and the TV or VCR does not, the same programming may appear on two different channel numbers. One channel number will be found on the set top terminal and the other on the TV or VCR. This may be confusing.

19.3.6 Problematic Connection Example

Figure 19.6 is illustration 7 of the NCTA connection diagram set. This figure is almost never used with modern set top terminals because they usually require a separate frequency for receiving control signals. The VCR would block those signals, and the set top terminal would turn itself off after a preset time. Also, this configuration would block upstream signals, making impulse pay per view (IPPV) and other two-way services impossible.

Advantages

1. Attempts similar functionality to Figure 19.4 but without the need for the A/B switch.
2. PIP can be used with the second picture unscrambled if the TV has baseband inputs connected to baseband outputs from the VCR.

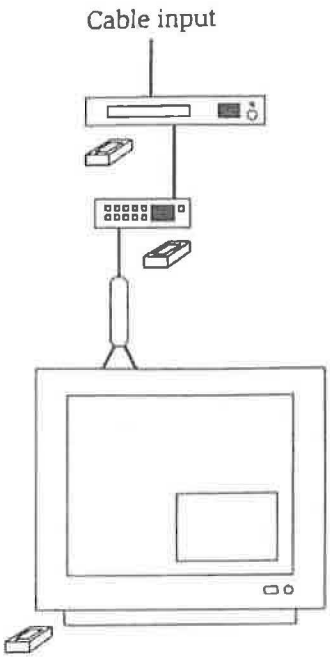


Figure 19.6 Connection with set top terminal difficulties.

Disadvantages

1. Many set top terminals can't be used in this configuration.
2. Impulse pay per view and other two-way services are impossible.
3. Can't record scrambled programs.
4. TV's parental control, favorite channels, and last channel recall features are inoperative. The TV is just tuned to channel 3 (or 4).
5. Need to use three remote channels or a universal remote control.
6. Converter/descrambler's parental control is inoperative when using VCR's channel 3 (or 4) output.

Special Cases

1. If the converter/descrambler has an auto bypass switch, then when the set top terminal is off, the entire output of the VCR passes through to the TV, and the situation is exactly the same as in Figure 19.1.
2. If the set top terminal has the channel-mapping feature and the TV or VCR does not, the same programming may appear on two different channel numbers. One channel number will be found on the set top terminal and the other on the TV or VCR. This may be confusing.

19.3.7 Improvements

One of the main disadvantages of the configurations shown in Figures 19.2, 19.3, and 19.5 is that the VCR is not able to consecutively record different programs except if the set top terminal has an auto bypass switch and no scrambled programming is to be recorded.

This disadvantage can be overcome, at least in theory, with set top terminals that include a programming function similar to that found in VCRs. This programming function can be set up to turn on and change channels at appropriate times. Usually, an on-screen menu is used for this purpose. The subscriber then uses the same principles to program the set top terminal as are used to program the VCR, with the VCR programmed only to turn on and record the output channel of the set top terminal at the appropriate time. In practice, this procedure meets with limited success by the occasional user since there are additional opportunities to make mistakes and thereby fail to record the desired programs. Nonetheless, the careful subscriber can master these techniques and successfully record different channels consecutively.

An alternative approach to overcoming the deficiency that inhibits the recording of consecutive programs on different channels is found in certain premium VCRs. These products have an infrared (IR) light emitter on a short wire. This device is sometimes called an IR blaster. The IR control is set up to use the IR control codes of the brand set top terminal employed by the cable operator. The VCR can then change the channels of the set top terminal and thereby record different channels, scrambled or unscrambled, consecutively. Since the set top terminal is now controlled by the VCR, the set top terminal's remote control is not necessary. Only two remote controls are needed by the subscriber, one for the TV and one for the VCR.

In the case of Figure 19.3, this type of VCR overcomes yet another difficulty. That is, if the two set top terminals respond to the same IR codes, the VCR's IR controller can be placed in such a way that the set top terminal used with the VCR is isolated from the IR signals used with the set top terminal connected to the TV. Then only three remote controls are necessary, and both set top terminals can be controlled remotely.

It is possible to use the same IR blaster technique with the TV controlling the set top terminal (if the TV is so equipped). Also, the set top terminal may use an IR blaster to control the VCR or TV. In that case, the subscriber programs the set top terminal and uses its remote control.

An unfortunate complication with the IR blaster stems from the fact that the usual on–off control on consumer electronics products and set top terminals is a toggle function. That is, there is not a separate on and a separate off control. Rather, if the unit is on, the control turns it off, and vice versa. This uncertainty over the current state is a source of error in setup and usage of these techniques.

There are numerous complications in these configurations. Most subscribers have difficulty visualizing what is happening with the multiple remote controls or the multiple modes of use of the universal remote control.[5]

19.4 Consumer Electronics Interface Issues

19.4.1 The Importance of Compatibility

The cable–consumer electronics interface establishes the manner in which a cable system, a consumer, and consumer electronics products function together to provide a useful result. Compatibility means the convenient use of the features of in-home equipment that are of interest to the subscriber. It also means a minimum of hurdles to subscribing to advanced cable services. From the perspective of the cable operator, compatibility is an issue of customer service and satisfaction. Effective compatibility can be a strong competitive advantage over other service providers. It can mean the difference between subscriber retention and the loss of subscribers to other media.

19.4.2 The Participants and Their Priorities

To better understand the consumer electronics interface issues, it is helpful to consider the problems from the perspectives of the various participants. These participants have differing goals and desires that are not always in harmony.

There are five major participants: (1) the subscriber/consumer, (2) the service provider, (3) the service provider's equipment manufacturer, (4) the consumer electronics industry, and (5) government entities making laws and rules.

The subscriber/consumer is the ultimate objective of all the efforts. If the subscriber/consumer is not happy and if there are alternative entertainment and information choices, the result will be a loss of business. Of course, there always are alternatives. The simplest alternative is to simply not subscribe to premium services and just use an off-air antenna with videotape and video disc rentals as supplementary video.

The next participant to be considered is the service provider who has a love-hate relationship with the in-home hardware. Following is the service provider's equipment manufacturer who has legitimate business concerns. The participant that is most anxious to become an active player in this arena is the consumer electronics industry. Lastly, the Congress has established laws that require the FCC to regulate these matters.

19.4.3 The Subscriber/Consumer

The subscriber/consumer participates in two ways. The subscriber/consumer buys equipment from the consumer electronics industry and subscribes to services that play on that equipment. The ultimate goal is the services. Additional programming choices make the TV and VCR even more useful.

The best reason for a large screen and a surround-sound system with multiple speakers and high-wattage amplifiers is the premium programming that comes with pay services and pay-per-view events. Likewise, having a quality receiver and sound system makes movies and premium services more enjoy-

able. Given all this, it is clear that the cable and consumer electronics industries are highly motivated to work closely together to reinforce this symbiotic relationship.

The consumer wants good programming, good pictures and sound, cost-effectiveness, and simplicity. The subscriber does not care which medium makes the programming available. The consumer is frustrated with product features that are difficult to use and understand. The blinking "12:00" on the VCR has become emblematic of consumer technophobia—many consumers do not even know how to set the correct time. The maze of wires behind the TV and VCR are bad enough with just off-air reception, but they become beyond comprehension for many consumers when a premium service provider adds a set top terminal of some sort.

19.4.4 The Service Provider

There are two elements to the service provider participant: the cable operator and the program supplier. Although this is an interdependent relationship, there are differences in their priorities.

The service provider's love–hate relationship with the in-home terminal concentrates on its major disadvantage, the cost, and its major advantage, the facilitation of new services. The capital cost of the in-home terminal is a significant portion of the total capital investment required for service provision. This is especially burdensome with digital set top terminals.

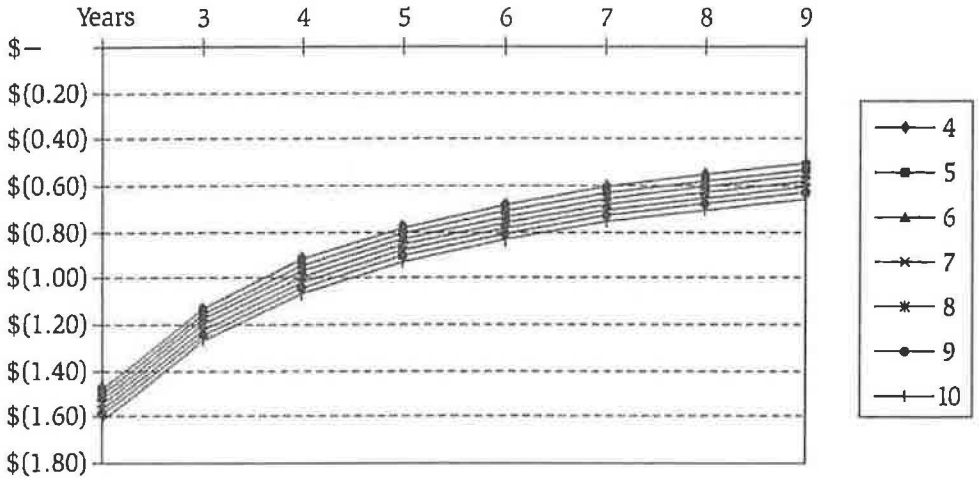
A rule of thumb used in the cable industry for a decade and a half is that for every $50 of in-home hardware, $1 a month is required just to cover the cost of the equipment. This rule of thumb is based on the assumption that the money to buy the set top terminal is borrowed from some capital source that requires repayment. The capital source may be internal or external, but capital is always a scarce commodity with multiple demands, each of which must justify its use. The capital must be repaid over the period during which the set top terminal remains functional, and the interest must meet corporate hurdle rates. Over the years that set top terminals have been used, the interest rate has varied over a wide range. Using the usual financial equations that are available in spreadsheet programs, Figure 19.7(a) shows a table of the amounts that must be paid back monthly to cover a $50 loan for various interest rates over a number of years. Figure 19.7(b) graphs this data with the number of years across the top, the dollars of outflow on the vertical axis, and a separate curve for each percentage value.

In the graph, the curves for the various percentages cluster closely. Clearly, the number of years over which the loan must be paid back is the more important parameter. Going from 3 years at 5% interest to 3 years at 10% interest increases the monthly cost by only 7%. Going from 3 years at 5% to 4 years at 5% reduces the monthly outlay by 23%. Long life of the equipment is important to low monthly costs. Conversely, high-tech equipment that is soon obsolete is very expensive on a monthly basis. In addition to repaying the capital for the set top terminal, there is a monthly maintenance cost.

Interest rate in percentage

Years	4	5	6	7	8	9	10
3	$(1.48)	$(1.50)	$(1.52)	$(1.54)	$(1.57)	$(1.59)	$(1.61)
4	$(1.13)	$(1.15)	$(1.17)	$(1.20)	$(1.22)	$(1.24)	$(1.27)
5	$(0.92)	$(0.94)	$(0.97)	$(0.99)	$(1.01)	$(1.04)	$(1.06)
6	$(0.78)	$(0.81)	$(0.83)	$(0.85)	$(0.88)	$(0.90)	$(0.93)
7	$(0.68)	$(0.71)	$(0.73)	$(0.75)	$(0.78)	$(0.80)	$(0.83)
8	$(0.61)	$(0.63)	$(0.66)	$(0.68)	$(0.71)	$(0.73)	$(0.76)
9	$(0.55)	$(0.58)	$(0.60)	$(0.63)	$(0.65)	$(0.68)	$(0.70)
10	$(0.51)	$(0.53)	$(0.56)	$(0.58)	$(0.61)	$(0.63)	$(0.66)

(a)



(b)

Figure 19.7 Set top costs. (a) Monthly cost of $50 loan at various rates paid back in multiple years. (b) Graph of data.

The benefit of the in-home terminal to the service provider is that it facilitates services. The in-home terminal does this in two ways. First, it provides the electronics necessary for the service. For example, a Web appliance provides the signaling, memory, and display electronics needed to browse the Web and display the results on the TV. Second, the in-home terminal is the instrument of conditional access. Unless access can be restricted, a price cannot be demanded. A wide variety of ways of protecting signals was discussed in the previous chapter. Nearly all of them require some in-home device.

Experience shows that consumers respond to the ability to make impulse purchases of programming. The easier the mechanism of purchase, the more is bought. This capability also requires some sort of in-home equipment.

The in-home terminal is one of the fundamental determinants of the quality of the video and audio experienced by the subscriber. Technical specifications such as noise figure, linearity, and the tightness of the shielding are critical to good pictures and sound. The need for a quality terminal is paramount.

Lastly, there is a need to be able to experiment with new services. In the past, this has been done by the system operator providing the in-home hardware necessary for the marketing experiment. If the service proves compelling, additional equipment is procured, and the service is rolled out across the population. The cable industry is very good at copying success and applying it widely. If the experimental service is disappointing, the equipment is abandoned and forgotten. In neither case is the consumer required to purchase new hardware that might be later orphaned. This is just an extension of one of cable's major marketing advantages. The salesperson can offer a low-cost or even a free trial hookup to the consumer without asking for the purchase of any equipment. Consumers know that if they are dissatisfied with the service, they may discontinue at any time without getting stuck with hardware that has no other use. This ability to offer a risk-free trial is an important advantage.

The program supplier's principal concern is protection against theft. Though this is important to the cable operator, it is even more critical to the program suppliers. The framers of the U.S. Constitution realized the importance of protecting the rights of authors, artists, and other creative workers when they provided for the copyright. Protection encourages the creative contributor. Without the fruits of these contributors, there would be no cable industry and no consumer electronics industry. The consumer would have minimal interest in what little would be left. Although the public may view theft of programming as a "victimless crime" or one of little significance, this is a misperception. All suffer from the loss of incentive to produce quality programming. Legitimate consumers pay higher prices because those who steal do not contribute their fair share to covering the costs of operation. Fortunately, the 1992 Cable Act, the 1996 Telecommunications Act, and the actions of the FCC have recognized the importance of preventing signal theft.

The program supplier is also interested in minimizing the impact of the copying of programs on other means of distribution. Businesses in the rental and sale of videotapes and video discs are undermined by easy copying of programming delivered on cable.

19.4.5 The Service Provider's Equipment Manufacturer

The priorities of the service provider's equipment manufacturer are perhaps easiest to understand. Its goal is to profitably sell systems involving large quantities of

in-home hardware and the headend equipment needed to supply signals. Since cable systems are individual closed systems of limited geographic area and since the in-home hardware has traditionally been leased, adjacent cable systems can utilize totally incompatible equipment and still well serve the TVs and VCRs owned by subscribers. The subscriber who moves from system to system is not inconvenienced by these incompatibilities since the system that serves the new residence will supply the necessary in-home equipment while the system serving the previous residence takes back its equipment.

A major advantage of this approach is that new technology is easily accommodated. When a cable system is ready to upgrade its hardware, it can purchase the best of the newest equipment available without concern about making the consumer's equipment obsolete. From the manufacturer's perspective, this keeps the market from becoming saturated. New services and new technologies can recapitalize the consumer's set top while bringing excitement to the service. Imprudently implemented consumer ownership of this equipment would interfere with this process of innovation.

19.4.6 The Consumer Electronics Industry

The consumer electronics industry has two main elements: the manufacture and the retail sale of products.

The nature of the consumer electronics business is one of high competitiveness. The manufacturer is interested in making more products and in selling upscale models. Almost 100 million residences receive television signals in one form or another in the United States. There are more than 250 million television receivers and 150 million VCRs in those homes. About 25 million new TVs and 15 million new VCRs are sold annually. The consumer electronics industry has the capacity to produce even more. Each year, new efficiencies make possible the production of more units from existing production lines. There simply is massive production overcapacity. The consequence of this is that it is impossible to maintain prices, much less raise them. Margins are tight. Only the full-featured products make money. The simple products now sell for something like $10 per inch of screen size. The cable set top terminal has the potential to interfere with attractive features in the TV and VCR. This drives the consumer toward the profitless low end of the product line. Clearly, this is a survival problem for the consumer electronics industry.

The retailer does not have the option of selling set top terminals to cable operators. Those are large-scale industrial sales that are seen by the retailers as a bypass of their business. The retailer's desire is either to totally prevent the use of set top terminals or to get into the business of selling them. After a few years of attempting to outlaw set top terminals, the retailers have come to realize that the age of interactive television, convergence, and advanced services requires set top terminals. The emphasis is now on requiring these devices to be available at retail.

19.4.7 The Two Extremes

After the 1992 Cable Act, discussions between the cable and consumer electronics representatives began in earnest. Some on each side adopted extreme and simple-minded positions. The extremists in the consumer electronics industry said, "Why don't they just not scramble?" Whereas the extremists in the cable industry said, "Why don't they just make monitors?"

Both of these outlooks are life threatening to the industries concerned. Without scrambling, cable cannot protect signals and offer premium services. This would spell the end of the cable business. Without premium features, the monitor business would degenerate into a profitless commodity business that would cause chaos to the consumer electronics sector. Neither alternative is workable. Neither alternative considers the consumer. Something else is required.

19.4.8 The Origins of the Problem

The history of the situation provides some help in understanding its complexity. The first "cable-ready" TV was almost an accident. A couple of decades ago, television tuners were analog devices with mechanical rotary turrets. A multitude of contacts switched coils, changing the frequency tuned and the local oscillator frequency. Remote control was implemented with a motor driving the shaft of the tuner. The tuner contacts wore out or oxidized, and the tuner became the major source of service problems. The digitally controlled varactor tuner was an innovation that tuned the receiver with electrically variable capacitors (the varactors) instead of screwing a ferrite core into a coil of wire. The tuning voltage for the varactors was derived from a digital-to-analog converter driven by digital electronics. The voltage data was stored in semiconductor memory. The same digital electronics served to implement the remote control. The advantage to the consumer was a significant increase in reliability because of the elimination of moving parts and the vulnerable electrical contacts. However, the cost of TVs with electronic tuners was around $100 more than comparable units with mechanical tuners, making these advanced receivers difficult to sell.

An engineer recognized that memory comes in fixed sizes and that most applications do not use all the memory available on the chip. He proposed filling the memory chip with additional data that allowed the varactor tuner to tune some nonbroadcast frequencies used on cable. With the addition of a cable television F connector to accommodate connection to a cable, the product could be sold as "cable ready." The additional cost was near zero—just better utilization of the memory that was already there. This was a feature consumers could understand. They were willing to pay more for "cable ready" because it promised to free them of the set top terminal.

As time went on, subscribers noticed that though the TV gave them access to some cable channels, it did not give them access to all. A "horsepower race" developed where the number of channels tuned was part of the advertising. As

more channels were added, a larger size memory was needed; this added a small increment of cost. Further increases in channel capacity required slightly more complex tuners. But this still was a minor cost increment.

19.4.9 Other "Cable-Ready" Issues

There are a number of important design features included in most cable set top terminals that very few "cable-ready" TVs and VCRs incorporate. Most cable set top terminals have a feature called channel mapping. Channel mapping decouples the channel display number from the frequency tuned. Thus, if there is a direct pickup problem in the cable system because of the presence of a strong broadcast signal, the broadcast channel can be placed at a different frequency to avoid this interference while allowing the subscriber to request it by its familiar channel number. The remote control command and the channel indicator all provide the familiar number while the tuner is "mapped" to another frequency. The set top terminal has downloadable control commands to change the mapping as channel lineups change and to suit the needs of the cable system using the unit. A consequence of the absence of this important feature in "cable-ready" TVs and VCRs is the annoying need for multiple channel numbers in many local program listings. The familiar channel number is used for those subscribers using a cable operator-provided set top terminal. An alternative channel number is used for "cable-ready" TVs and VCRs. This problem exists in the same home when some TVs have set top terminals and others do not or when the auto bypass feature is used with a set top terminal. Receivers built in compliance with the EIA-608A standard may include automatic channel mapping as an option.

A more important application of channel mapping is the manner in which scrambled channels are handled in a set top terminal. When a subscriber using a set top terminal attempts to tune a channel for which he or she is not authorized, the set top terminal avoids that channel. Either it goes to another channel that has an appropriate message or it simply presents a blue (or blank) screen and muted audio. The alternative channel may include advertising for premium cable services. In that case, it is referred to as a *barker channel.* The term comes from the circus "barker" who hawked sideshows and attempted to attract an audience. If a blue screen is used, it may include a text or graphics message indicating how the subscriber could upgrade the subscription. In either case, the video and audio are kept from the receiver. This feature allows for practical video scrambling that has relaxed constraints. The video scrambling does not need to completely hide the video. There is no concern that "objectionable" video might "bleed" through to offend sensitive viewers. Additionally, audio does not need to be scrambled since, in most cases, scrambling the video is sufficient to require a subscription. Children are protected from unintentional exposure to the audio of objectionable programming and do not accidentally see the "random lockup" of a scrambled video because of the set top tuner's mapping to another channel. This protection is lost when the "cable-ready" product does not include the same channel-mapping feature.

The television audio signal is complex. It includes a stereo component, a second audio program (SAP), usually for monaural second language, and auxiliary signals. Since the human ear is very sensitive to audio distortion, scrambling the complex analog television audio signal in a manner that results in quality sound when descrambled is expensive and technically challenging. This expense would be unnecessary if channel mapping were universally used.

Set top terminals have other important features as well. Parental control features are required by some franchises. These franchises often specify the manner in which the parental control feature must function and the level of security it must provide. "Cable-ready" TVs and VCRs usually have simplified parental control if they have the feature at all. Additionally, set top terminals often have an emergency alert feature that allows local government officials to alert citizens of hazardous conditions. "Cable-ready" TVs and VCRs do not include this capability.

19.5 Frustrated Product Features

Adding a set top terminal either makes certain features and functions of TVs and VCRs redundant or interferes with their operation. In most situations, the feature or function is not blocked, but its use requires additional effort that the consumer finds inconvenient. It is this frustration that motivated the compatibility section of the 1992 Cable Act.

19.5.1 Remote Control

Remote controls were included in even early set top terminals. The first remote controls were "wired." A long wire led to a separate unit positioned near the viewing chair and allowed channel changing without having to go to the TV. Cordless remotes based on ultrasonic tones, infrared light waves, or radio links were introduced later on. Consumers were able to add the remote control feature to existing nonremote-controlled TVs by utilizing the cable set top terminal. This was seen as an important ancillary advantage to a cable subscription. The consumer electronics industry was not pleased with the slowing impact this had on replacement sales. However, a benefit accrued in that consumers were presold on the advantages of remote control. It became almost impossible to sell a new TV or VCR without remote control.

A problem arises when both the TV and the set top terminal are remote controlled. The customer may feel he or she paid for a remote control feature on the TV that is not needed because the set top terminal has the remote control. Worse yet, the consumer may need to juggle two remote controls. He or she may have to use the TV's remote to turn it on, put it to the output channel of the set top terminal, and adjust volume. The consumer then uses the set top terminal's remote to change channels. The set top terminal often includes a switched convenience power outlet. This works well with older, nonremote-controlled TVs. But there

are problems with remote-controlled TVs. These products usually have a toggle on–off push button, which means that simply powering the line cord does not result in the TV going on. Worse yet, if the TV has an automatic channel setup feature, it will go through the setup procedure every time it is repowered. Since this takes several minutes, the result is unacceptable. The net result is the juggling of two remote controls. Note that the same situation exists in a noncable application where the VCR is connected between the antenna and the TV.

19.5.2 Timers

When a set top terminal is used with a VCR, further complications are encountered. Since the VCR timer controls only the VCR, it cannot turn the set top terminal on and off, and it cannot change the terminal's channel. Early on, this was recognized, and set top terminals with built-in timers have been available for well over a decade. The very same techniques used for programming the VCR are used for programming the set top terminal. The consumer who can do one can do the other as well. Unfortunately, most consumers do this function so infrequently that they must relearn it every time they wish to record a program. The chances for error are great, and the success rate is low. This leads to frustration. The majority of consumers—cable and noncable—use VCRs for playback of prerecorded tapes and just avoid these headaches.

Some set top terminals have the ability to set their clocks using signals coming from the cable headend. Thus, their time is always correct, even in spring and fall when daylight savings time changes occur. Some newer VCRs implement this feature with signals from the broadcaster. Another common timer found in TVs is the sleep timer. Although a cable set top terminal does not interfere with the TV's sleep timer operation, some set top terminals have a sleep timer that makes one of the two timers redundant.

19.5.3 Picture-in-Picture

Picture-in-picture (PIP) is the insertion of a small picture within the larger picture. The purpose is to be able to monitor a second program while watching and listening to another program. If the action in the second program becomes compelling, the two images can switch places with the push of a button. Most TVs above the basic models include PIP.

There are a number of implementations of PIP. The most common embodiment has only one tuner, which is used for the main picture; the image for the second picture comes from an external device—usually a VCR's tuner. Other video source alternatives include a baby-monitor camera or a front-door camera. More expensive TV receivers have two tuners. An advanced form of PIP can be operated to scan through channels and put up a mosaic of small still pictures from a number of channels. As such, it is a kind of program guide that allows owners to scan the channels prior to making a selection.

In a TV with two built-in tuners, a problem arises if an internal splitter is used and the set top terminal is placed ahead of the single antenna input. In that case, the output of the set top terminal appears on both the large and small pictures. If on the other hand, two antenna inputs are provided, the use of the set top terminal is noninterfering except when the customer wishes both pictures to come from scrambled channels. In that case, two descramblers are required.

The least common PIP implementation is the one that presents a mosaic of pictures from various channels. This system is interfered with since the program selector is in the set top terminal and is not under the control of the TV receiver.

19.6 Early Attempts

There were a number of early attempts to solve or mitigate the compatibility problems between consumer electronics and cable systems. All proposed solutions were partial. The 80/20 rule applies. Eighty percent of the problem can be solved with 20% of the effort (and expense). However, solving the remaining 20% of the problem takes 80% of the effort.

19.6.1 Universal Remotes

Universal remote controls sought to alleviate the need for using two or more remote controls with the set top terminal and TV or VCR. The universal remote control is configured for the brand TV, the brand VCR, and the brand set top terminal. Simple universal remote controls have a hidden row of switches that are configured according to printed instructions that come with the device. An alternative approach is to enter appropriate setup codes from the printed instructions. Most models direct the channel change commands to the set top terminal, the volume commands to the TV, and the on–off commands to both units. VCR control can also be accommodated. Either a slide switch or a mode button governs which device is primarily controlled.

A problem arises with simple universal remote controls when a new model of TV, VCR, or set top terminal becomes available or if a favorite feature of the TV or VCR is not included in the universal remote control. "Learning" universal remote controls solve this problem by allowing the universal remote control to learn the signals emitted by the remote control that comes with the product. A disadvantage is the complexity; some consumers seem unable to master the instructions. Another type of learning universal remote control uses acoustic signals from the telephone to enter the data requested by the customer.

Advanced universal remote controls include *macros*. A macro is a collection of commands emitted in response to the pressing of just one button. For example, a common macro is the advanced on command. First, the set top terminal is turned on, then the TV receiver is turned on, then the TV receives a command to tune to the output channel of the set top terminal. It is important that all the

devices "see" the complete IR emission sequence and respond appropriately, or the result may be disappointing.

Another model of advanced universal remote control includes a clock and a timer. The remote control can be positioned so that it simultaneously communicates with both the VCR and the set top terminal. The universal remote control is programmed with the VCR control instructions. The remote turns on the VCR at the appropriate time, ensures that the VCR is tuned to the output channel of the set top terminal, then tunes the set top terminal to the desired channel, and finally starts the VCR recording. Consecutive recording of different channels is made possible.

A few models of two-way remote controls have a small screen on the remote control that displays signals received from the set top terminal. Titles of songs, purchase order forms, interactive games, and other instructions can be viewed.

19.6.2 Electronic Program Guides

Electronic program guides (EPGs) have been introduced with features that alleviate some of the interface problems. The EPGs are available as stand-alone devices, built into cable set top terminals, or built into TVs or VCRs. Several of these devices include one or more infrared light-emitting diodes (LEDs) on short wires that are meant to be attached near the remote control window of the VCR, the cable set top terminal, or the TV. The device with the EPG controls the other devices to accomplish the desired result. If the EPG is built into the cable set top terminal, the LED controls the VCR so that it turns on and off at the correct times and is tuned to the correct channel. If the EPG is built into the VCR, the LED controls the channel on the cable set top terminal. Of course, none of these approaches can ensure that sufficient blank tape has been put into the VCR!

A related device, called VCR Plus, uses numeric codes published in printed guides (or conveyed electronically in a later version) to the VCR or to a form of universal remote control. The codes are decoded using a proprietary algorithm to derive the start and stop times and the channel number. Infrared emissions control the VCR and cable set top terminal.

19.6.3 The TV Integrating Device

In the mid-1980s, the research department of a cable operator, American Television and Communications in Englewood, Colorado, began development of an approach the engineers called the TV integrating device (TVID). It was intended to be included in a cable set top terminal and to use IR LEDs to control the TV and one or more VCRs. It had a built-in EPG and an on-screen display. The goal was to provide a simple menu that would allow subscribers to indicate their desires. The subscriber would indicate what he or she wanted recorded and what he or she wanted to watch. The TVID would take care of switching the descrambler into the correct part of the system and turn things on and off at the right time to implement the subscriber's desires. If a conflict arose, such as wanting to watch a

scrambled channel while recording another scrambled channel, the subscriber would be advised of his or her choices and allowed to act upon them.

The TVID included a "mood guide," which gave the subscriber a way of indicating his or her mood. Those programs that were appropriate to his or her mood would then be displayed for selection to watch or record. The microprocessor could keep track of the programs watched and deduce the subscriber's interests. The subscriber would then be alerted to future programs that fit his or her previous viewing habits. The project reached the early prototype stage but was not completed because of other priorities.

19.7 Management of Expectations

Most of the subscriber's problems have solutions. Some solutions are more complex than others. The crux of the compatibility problem seems to be the expectation that the term "cable ready" brings. To consumers, this means that the TV or VCR can be connected to cable and all features and all services are readily available. When operation of features is complicated or unexpected results are obtained, frustration and anger set in. If instead, expectations were properly managed and the subscriber/consumer had a correct understanding of what was possible, the likelihood of disappointment would be reduced. The fundamental problem is the management of expectations.

19.7.1 Complexity Overload

A major contributor to the difficulties of the consumer electronics interface is the wide variety of choices available in features and functions, the way in which the features and functions are operated and controlled, and the diversity of services offered by cable operators. The number of combinations and permutations is almost infinite. Just the simple matter of entering channel numbers has several methods. Some products use an enter button. Others prescribe the way in which the digits must be entered. For example, on some products, requesting channel 7 requires pressing 07. Others can require waiting for a fixed time after entering the command. The names for common functions are brand specific. The number of complex features boggles the mind. It may simply not be possible to preserve all the product functions and features while offering access to all the available cable services.

19.8 Legal Aspects of Cable–Consumer Electronics Compatibility

19.8.1 Compatibility Definitions

The word *compatibility* should mean that two things work well with each other. In the case of compatibility between cable service and consumer electronics,

compatible should mean that the subscriber should be able to enjoy the cable services of interest and the features of the consumer electronics that he or she finds appealing. The subscriber should be able to conveniently do both.

Note that compatible is a situational definition. If a subscriber takes only basic (unscrambled) service from a cable system with a modest number of analog channels and is located far from strong interfering broadcast signals, he or she may enjoy all the functions of his or her "cable-ready" TV and VCR. If the subscriber then decides to add a scrambled service or moves near a broadcast transmitter, the situation changes significantly. He or she may lose compatibility between the TV or VCR and the cable system.

19.8.2 The 1992 Cable Act's Definition of Compatibility

Senator Patrick J. Leahy (Democrat from Vermont) drafted and introduced a bill in 1991 pertaining to the operation of cable systems and the design of consumer electronics products so as to improve compatibility. The bill did not pass. In the following year, it was introduced as Section 17 to the 1992 Cable Act.[6] Section 17 requires the Federal Communications Commission (FCC) to create rules to improve the compatibility between cable systems and consumer electronics products. The effect of this section of the law was to define compatibility as having three principal aspects:[7]

> (i) to watch a program on one channel while simultaneously using a video cassette recorder to tape a program on another channel;
> (ii) to use a video cassette recorder to tape two consecutive programs that appear on different channels; and
> (iii) to use advanced television picture generation and display features

Although this definition of compatibility may not be complete, it does define a requirement for the FCC's rules.

The bulk of the 1992 Cable Act pertains to economic issues such as rate regulation, the rules for buying and selling systems, and the permissible business relationships between programmers and operators. A small, but very important part of the Cable Act concerned the interoperability of cable systems and consumer electronics products. Though the 1992 Cable Act gave the FCC a difficult assignment, it also laid down some guidelines. The FCC was told to consider the costs and benefits to consumers of its rules and the provision of effective protection against theft. But the ultimate goal was clear: the minimization of interference with certain special functions in consumer electronics devices when connected to cable systems.

The FCC was given some new authority to help it achieve these goals. The FCC's primary influence over the cable industry was granted in the following clause: "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."

The authority given the FCC over the consumer electronics industry is much more limited: "to specify the technical requirements with which a television receiver or video cassette recorder must comply in order to be sold as 'cable compatible' or 'cable ready.'"

To ensure that the goals of compatibility continued to be pursued in the future, the FCC was given continuing responsibility:

> The Commission shall periodically review and, if necessary, modify the regulations issued pursuant to this section in light of any actions taken in response to such regulations and to reflect improvements and changes in cable systems, television receivers, video cassette recorders, and similar technology.

Further requirements imposed on the operation of cable systems included obligations for the FCC to:

> promote the commercial availability . . . of converter boxes and of remote control devices to the extent technically and economically feasible, to offer subscribers the option of having all other channels delivered directly to the subscribers' television receivers or video cassette recorders without passing through the converter box.

The FCC was required to provide a report to Congress within a year of the passage of the act. This voluminous report was based on the extensive responses to the FCC's initial notice of inquiry on the subject. The FCC issued a notice of proposed rule making on November 10, 1993, and released its first Report & Order on May 4, 1994. In those documents, the FCC indicated its directions:

> [W]e clarify that the compatibility regulations being adopted herein apply only to cable systems and do not apply to . . . video dialtone services.
>
> Signal thieves [have been] notoriously successful. . . . We will not require cable systems to allow their subscribers to own descrambling equipment.
>
> [W]e expect that the Decoder Interface connector will be flexible enough to accommodate most, if not all, of the attributes of cable digital service.

The FCC realized that there is an extensive installed base of more than 11,000 cable systems, more than 250 million television receivers, and more than 150 million VCRs. In addition, approximately 100 million TV households purchase around 25 million color TVs and about 15 million VCRs each year. No law could bring compatibility to this situation in a short time. The FCC divided its approach into three periods: short-term measures, intermediate-term measures, and long-term measures.

In the short term, cable operators were required to avoid scrambling the basic services, which consisted of mostly the broadcast channels carried on cable. In addition, the cable operators were required to provide certain equipment such as switches to bypass the entire spectrum around the set top terminal when the terminal is not required for descrambling, and timers in set top terminals to change channels at specific times. Cable operators were given a year to make available

multiple tuners and descramblers in set top terminals. They were allowed to charge for the costs of this equipment and its installation. Additionally, the consumer electronics industry was given a year to discontinue the use of the terms "cable ready" or "cable compatible" or any similar terminology in the sale of TVs or VCRs that did not fully comply with the FCC's promised technical definition of "cable ready." A rule was included that would have required a label on devices that tuned cable channels but did not fully comply with the FCC's definition of "cable ready," notifying consumers that this device may under some circumstances fail to provide satisfactory performance when connected to cable. The consumer electronics industry managed to get this rule reversed and gained a relaxation of other rules in a subsequent petition for reconsideration submitted to the FCC. The FCC imposed a bizarre rule prohibiting the cable industry from changing infrared codes in each set top terminal installed in each home in order to protect the home owner's "investment" in purchased remote controls. This rule was all but impossible to follow because of the large number of different codes. It was removed in response to a subsequent petition for reconsideration. Also, the FCC recognized the aggressive work of those who would steal signals:

> [W]e are clarifying that the availability of set-top devices from retailers applies only to basic converters without descrambling or other access control function.
>
> [W]e do not believe it is desirable to require cable operators to make their security technology available for ownership by the public.

The FCC then separately considered longer-term measures centered around the decoder interface (described in the previous chapter) being developed by the Joint Engineering Committee of the National Cable Television Association and the Electronic Industries Association: "We . . . emphasize . . . the Decoder Interface connector and associated component descrambler/decoders to be an important part of . . . equipment compatibility."

The FCC envisioned a digital world that would ultimately be based on standards and methods that avoided the problems of compatibility. The FCC intends to consider that environment separately in future actions.

19.8.3 The 1996 Telecommunications Act

The Communications Act of 1934 created the Federal Communications Commission and set the original public policy on communications. There have been multiple amendments to that act over the years, making it a quilt of patches. Additionally, technology had changed so dramatically that a complete rewrite became necessary. The result is the 1996 Telecommunications Act.[8] Although the act has a wide range of impact on cable television practice, only the portions pertaining to compatibility will be discussed here.

Probably the most important provision of the 1996 Telecommunications Act pertaining to compatibility is Section 304, "Competitive Availability of Navigation Devices," by Representative Thomas J. Bliley Jr., of Virginia:[9]

> (a) The Commission . . . in consultation with . . . industry standard-setting organizations . . . [shall] assure the commercial availability, to consumers of . . . services offered over multichannel video programming systems, of converter boxes, interactive communications equipment, and other equipment . . . from manufacturers, retailers, and other vendors not affiliated with any multichannel video programming distributor. Such regulations shall not prohibit any multichannel video programming distributor from also offering . . . equipment . . . if the system operator's charges . . . are separately stated and not subsidized.

The national headquarters of Circuit City stores is in Congressman Thomas Bliley's district, and his efforts to further the interests of an important constituent are clearly evident in this legislation.

The term *navigation devices* is a strange one. It has not been used in the cable or other related business except in reference to electronic program guides and related means of helping consumers find their way—navigate—through the wide variety of services available on systems with hundreds of channels. The law uses this term to mean any converter or set top terminal intended to go between the service provider's terminal and the TV or VCR.

Several important points should be noted. Although the 1992 Cable Act was restricted to cable operators, the 1996 Telecommunications Act applies to any multichannel video programming distributor. Additionally, the services covered are not limited to video.

Limits were placed on what must be sold in order to protect the interests of programmers and system operators.

> (b) The Commission shall not prescribe regulations . . . which would jeopardize security of multichannel video programming and other services . . . or impede the legal rights of a provider of such services to prevent theft.

In order to accommodate experimentation with new services and technologies, the law provides for waivers allowing a period in which hardware can be under trial.

> (c) The Commission shall waive a regulation adopted under subsection (a) for a limited time upon an appropriate showing . . . that such waiver is necessary to assist the development . . . of a new or improved . . . service.

A number of significant hazards are brought about by this legislation. The most important hazard is that the other users of cable systems and of the over-the-air spectrum could suffer interference and degradation of service when consumers purchase their own navigation devices. Second, consumers are subject to confusion with these complex devices. Money may be wasted on features that are unusable or not needed. When technology changes, consumers will be stuck with orphaned hardware. In some cases, the ownership of equipment will create a reluctance to try new services that require additional hardware that partially duplicates what has already been purchased.

It is likely that many, if not most, subscribers will continue to lease equipment because of the many benefits that come from such an arrangement. The

equipment is matched to the services provided. New equipment replaces old when technology evolves, service of equipment is included in the lease, and assistance on its use is readily available.

The other major portion of the 1996 Telecommunications Act pertaining to compatibility is Section 301(f), the "Eschoo Amendment" by California Congresswoman Anna Eschoo. This amendment modifies the compatibility rules of the 1992 Cable Act by putting restrictions on the FCC's actions. Specifically, it calls for mandating "a minimum degree of common design and operation, leaving all features, functions, protocols, and other product and service options for selection through open competition in the market." The goal of this amendment is to prevent the FCC's rules from picking winners and losers in a competitive environment where a variety of different approaches—some proprietary and others public—are vying for the same customer. Though that is a laudatory objective, it does make a difficult and complex task more challenging.

19.9 Standards

19.9.1 The Need for Standards

The cable industry has traditionally had little need for additional standards because it provides signals usable on the consumer's ordinary television or radio. The goal has always been to allow the consumer to take cable service without having to purchase additional equipment. A major attraction to cable is the ability to try a subscription with little investment and the assurance that it is easy to drop the subscription if it is disappointing. So the most important standard is NTSC. When the cable system provides services beyond the ability of the consumer's TV, an adapter is provided to allow access to the additional services. The earliest adapters were just tuners that gave access to channels beyond the range of the TV receiver. Since a cable system is a closed universe unto itself, there is no need for interoperability with adjacent cable systems.

Conditional access and scrambling are deliberately not standardized. Standardization of these functions would give the signal thief a larger market to sell "pirate boxes." By having multiple types of conditional access and scrambling, the garage manufacturer of pirate boxes is frustrated. Since the service provider has ownership of the conditional access equipment, he or she can decide when the economic losses due to a breach of the security system are of sufficient magnitude to require replacing the equipment. When the service provider replaces the equipment, the consumers are not adversely affected.

The 1996 Telecommunications Act includes a section that requires the FCC to make rules that will regulate how multichannel video service providers will make in-home equipment available at retail. Now, for the first time, there is a need for standards. Consumers who purchase equipment for connection to cable need to be assured that it will work when they move to another cable system. Fortunately,

the law and the FCC have recognized the problem of signal theft and have included a clarification that security systems do not have to be made available for subscriber ownership. There are three types of standards: mandatory, official voluntary, and de facto.

19.9.2 Mandatory Standards

Mandatory standards are those imposed by law or as a result of law. In the former case, the law itself contains the standards; in the latter, more common case, the law directs a government agency to do the difficult work and create rules. The FCC is the source of rules that govern the cable industry. There are two major sets of rules: (1) Part 78, the Community Antenna Relay Service (CARS) rules, which regulate the use of microwave links to convey signals across natural or man-made barriers or simply to transport the signals from one location to another where the geography in between does not have the cable service, and (2) Part 76, which governs the operation of the cable system itself. The items regulated include safety, signal leakage, and minimum performance requirements. These were first put into place in 1972 and then immediately stayed while further deliberations took place regarding the details. The performance rules cover frequency stability, carrier-to-noise ratio, allowable interference, in-band frequency response, hum content, adjacent channel response, cross modulation, must-carry and retransmission consent, and signal leakage. The rules (with the exception of signal leakage) apply only to Class 1 signals, which are defined as signals originally broadcast. However, the rules cover only additional performance deficiencies. The cable operator is not responsible for problems in the signal as delivered to the cable headend. Class 2 signals are satellite-delivered programming, and Class 3 signals are locally originated. The rules were suspended by the 1984 Cable Act, which deregulated cable. At that time, they were converted into a recommended practice. Local governments were permitted to create their own rules, but those rules could not be more severe than the recommended practice. This was challenged by the League of Cities. A consequence of this was that a panel of representatives from the cable industry, the FCC, and the League of Cities negotiated a set of rules that has become the current FCC Part 76 in 1991.

19.9.3 Official Voluntary Standards

Voluntary standards do not have the force of law. The main motivation for compliance with the standard is the ability to use the fact of compliance in marketing efforts. Official voluntary standards have the sanction of a standards-setting organization. The primary standards-setting organization in the United States is the American National Standards Institute (ANSI). ANSI has very rigorous rules for the procedures involved in setting these standards. The rules are intended to ensure that participation is available to all interested parties and that due process is followed. ANSI certifies organizations as complying with these rules. Currently,

the primary ANSI-certified cable organization is the Society Cable of Telecommunication Engineers (SCTE). Another organization that has worked to develop standards that govern both the cable industry and the consumer electronics industry is the Consumer Electronics Manufacturers Association (CEMA) sector of the Electronic Industries Association (EIA). Although CEMA is the official ANSI standards-setting organization, its efforts are under the auspices of the Joint Engineering Committee (JEC) of the EIA and the National Cable Television Association (NCTA) Engineering Committee.

The SCTE has about 100 standards under development at the time of this writing. Five of those standards are in a condition where they are suitable for submission to ANSI. One of those standards has been approved as ANSI/SCTE PS SP 400 1996 F-Port (Female Outdoor) Physical Dimensions. Next will be the 5/8-24 RF Outdoor Fitting Physical Dimensions standard. The Digital Video Transmission Standards for Cable Television is expected to be submitted before the end of 1998.

The JEC efforts began in the very early 1980s and have not been nearly as successful in completing standards. This lack of results is an indication of the difficulty involved in the interface between cable and consumer electronics. Its first standard, the ANSI/EIA-563 Decoder Interface Standard,[10,11] was in place for several years and then officially withdrawn. Another standard, EIA-542 Cable Television Channel Identification Plan,[12] lists channel numbers and frequencies for three different channel plans: the standard plan related to the broadcast frequency plan, the harmonically related carrier plan, and the incrementally related carrier plan. Though this standard has been slow to make its way through the official process, it has been used by both the cable and the consumer electronics industry as a de facto standard for more than a decade. Both industries have found it a useful means of cooperation.

One of the most important JEC standards is the EIA-IS-105[13] Decoder Interface Standard described in the previous chapter. Other standards in the works include the National Renewable Security Standard (NRSS)[14] and the RF Interface Standard IS-23.[15] An effort to create a digital television standard has been transferred to the SCTE. The IS-23 standard governs such parameters as the physical connection to cable, the frequency response, the signal levels, and direct pickup by inadequately shielded components.

19.9.4 De Facto Standards

De facto standards are the result of marketplace forces where the cable industry has settled on a particular approach because it works well. The types of connectors, cables, amplifiers, and other equipment used in cable have been sorted out by the marketplace, and a limited set of models have evolved on a de facto basis. Some of these de facto standards are being converted into official voluntary standards by the SCTE. This approach has served the industry well and will continue to be in use.

19.10 OpenCable

Cable Television Laboratories, or CableLabs, has undertaken a program intended to provide options for alleviating many of the interface problems. The goals of the program, called OpenCable, are to provide sufficient standardization of features and functions so that a multivendor interoperable environment can be created. CableLabs will certify compliance with OpenCable.

Initially, OpenCable will allow cable operators to utilize set top terminals from multiple vendors. Though OpenCable is primarily directed at digital set top terminals, it optionally includes analog descrambling. OpenCable set top terminals that CableLabs certifies as compliant will eventually be available at retail. Finally, it can be expected that OpenCable functions and features will be included in consumer electronics products. OpenCable is described in more detail in Chapter 3.

19.11 National Renewable Security System

The Joint Engineering Committee formed a subcommittee called the NRSS subcommittee to consider methods that could overcome a security breach. The motivation is to facilitate the sale of set top terminals or consumer electronics products while protecting the conditional access system by having it renewable in the event the system is defeated. The initial approach involved the Smart Card system, which was used for conditional access and for credit and debit cards. The Smart Card was intended to include a digital key that would decrypt the digital signal.

After some discussion, it was decided that the only safe approach is to have every transistor involved in the security function replaceable in a module that plugged into the set top terminal. A wide variety of proposals were considered. One of the proposals used the Smart Card physical format but put a lot more electronics on it. This NRSS Type A card complied with the International Standards Organization (ISO) 7816 standard. Several limitations flow from this. There are only eight contact pads, forcing the MPEG signal to be transported serially. There is no mechanism for handling cable's out-of-band signaling. Eventually, the committee settled on an optional Type B approach based on the Personal Computer Manufacturers Communications Interface Adapter (PCMCIA) Type II standard card. This card has 68 pins, which is adequate to allow the set top terminal to convey out-of-band signals received by a built-in modem.

The NRSS standard, designated the EIA-679, has been balloted and passed. It is under the EIA's auspices since the NCTA is not a standards-setting organization and the work began before the SCTE became accredited to set standards by ANSI. Work continues on optional extensions to the standard. Proposals for an optional PCMCIA card that itself could accept an ISO 7816 card have been made. Another

manufacturer suggested an extended PCMCIA card with an on-board single chip tuner. The 1394 "Fire Wire" communications protocols are being studied.

It is recognized that the NRSS system is a necessary but not sufficient condition for the implementation of digital set top terminals and consumer electronics products that can be sold at retail. At least two issues remain. The first is the requirement that upstream signals be possible for two-way interactive services. This can be handled by having the cable connection first go to the NRSS card, loop through the card, and then go to the set top terminal or consumer electronics product. The second requirement involves the graphical user interface (GUI) of the cable service. Since the NRSS does not process the signal as a baseband video signal, it is not possible to simply cut graphics into the video. Another access point is required for GUI processing.

19.12 Summary

The interface between cable service and consumer electronics products affects the quality of service and the ease of use of a service. In severe cases, the interface prevents access to a service. This same problem interferes with the ease of use of some of the functions and features of consumer electronics products. These problems are complex because of the wide variety of services, functions, and features possible with modern methods.

The JEC and its subcommittees have been working diligently for more than a decade on ways of alleviating the interface problems. Just the increased understanding between the technologists of the two industries has helped. Products and cable practices now more fully accommodate the interface issues.

Although a great deal of progress has been made, much is left to do. We are hopeful that the solutions found in digital implementation will be more satisfactory because of the lessons learned in the struggle with analog systems.

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