CABLE TV ADVANCES AND TV RECEIVER COMPATIBILITY PROBLEMS

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ABSTRACT

The new "cable ready" TV sets are not compatible with new cable TV systems that provide multiple PAY TV services using addressable, programmable, converter/descramblers. "Baseband" converters with demodulation, descrambling and remodulation are becoming more popular. Subscriber ownership of terminal equipment would be very desirable but requires a nationally standardized encoding and addressing technique.

TROUBLE!

I am reminded of the lines from the Broadway musical "MUSIC MAN" - "You've got TROUBLE my friends, right here in River City..... With a capital "T" that rhymes with "P" and that stands for POOL!" There is "trouble", my friends, right here in the consumer electronics industry in America, with a capital "T" that rhymes with "C" and that stands for CABLE.

I don't believe that the consumer electronics industry properly appreciates the recent changes and developments in the cable television industry and how they affect consumer electronics. In effect, a new consumer electronics industry - cable television "subscriber terminals" - is growing up outside the present "establishment" . The manufacturers of these products seem to be developing them mostly without the benefit of the engineering experience of established manufacturers of television receivers, although there is some overlap of know-how. The situation is apparant in the nature and the shortcomings of the products being offered to the public.

Many receiver manufacturers are now marketing "cable ready" receivers. These TV receivers are perhaps ready for our cable systems of three years ago. They are by no means "ready" for the cable systems we are designing and building today. Our newest cable systems have dual cables each with 50-440 MHz bandwidth and carry up to 61 TV channels in each of the two cables. All of our new systems have multiple scrambled PAY TV channels. The descrambling is usually built into the tuning converter. Even if our subscriber has what most TV manufacturers call a "cable ready" TV set we cable operators still have to provide the suscriber with our "addressable, programmable converter/descrambler" (APCD). The money and effort that went into the "cable ready" TV set is mostly wasted in our new cable systems. Some of our newest systems use "baseband" converters which:-

tune all channels between 50 and 440 MHz

automatically select between an "A" and a "B" cable drop

have infra-red remote tuning control

have remote audio level and muting control

have programmable descramble functions which are addressable from the cable system head-end

have baseband video and audio outputs for VCR's and video projectors

have built-in "emergency alert" so that they can be turned on, tune emergency channel and turn up audio on command from the cable system head-end

have digital "parental guidance" lock so that subscriber can program the terminal not to descramble "objectionable" channels or programs

have optional RGB output for special monitor functions such as high quality TELETEXT display

have optional built-in TELETEXT decoding

digital clock and tuned-channel display on TV screen

etc.

There is unfortunately a substantial redundancy in all of this which the public is paying for. The cable subscriber has bought a TV set with tuner, demodulator and remote control function. We cable system operators provide him with another very similar set of functions. The subscriber ultimately pays for both. There obviously must be an early accomodation and understanding of who will provide what. It has to start with a thorough mutual technical understanding.

NEW PROBLEMS

The television receiver industry has approached the matter of "cable compatibility" from the standpoint of channel tuning, adjacent channel selectivity, and succeptibility to strong ambient RF fields. These seemed to be the compatibility problems when I first raised the question of compatibility in a paper presented to the IEEE Consumer Electronics Conference in 1971 - more than ten years ago.

The major factor in the changing cable systems environment has been the advent of multiple PAY-TV services and the rapid recent growth in cable television service offerings. Our newest cable systems offer dual-440 MHz cable systems carrying up to 61 channels on each cable. We insist on remote tuning capability in all of our new converters. We refused to buy one manufacturer's converters for many years because they did not offer remote tuning versions of their converters. It is ridiculous to offer a 54 or 122 channel system and then provide only a "set-top" converter which will compel subscribers to get up off their chair every time they want to change channels. The cable industry has sold subscribers on the idea that they would want to change channels often because we offer such a large number and variety of channels. Remote tuning capability is an essential feature of a modern cable service offering. Remote audio control is equally attractive as a subscriber service offering.

I was called some time ago by a senior design engineer for one of the American TV receiver manufacturers. We had just introduced 400 MHz/54 channel cable systems technology. He was designing new "cable ready" tuners and he wanted to know whether 400 MHz would be the end of cable system spectrum development. Just how much tuning range should he build into a new "cable ready" TV set? I wasn't able to give him any assurances about limitations to cable system spectrum usage, in fact 440 MHz equipment had just been announced. After talking about it for a while we decided that it didn't really matter because it was just no longer possible to honestly talk about "cable tuning" as being the basis for a "cable ready" TV receiver. The pressures of PAY TV control and provision of other services has forced us to provide our subscribers with terminal equipment to control PAY TV access and in some cases to monitor PAY TV usage. Inevitably this equipment has become integrated with the tuning function, removing tuning from the function of the subscriber's receiver.

BASEBAND CONVERTERS

"Baseband" converters are now available from several manufacturers. I have given the matter of baseband converters very serious consideration and have discussed them with several cable systems equipment manufacturers. They have been introduced principally to provide more flexibility in "scrambling" techniques and to provide access to information transmitted in the vertical interval.

These are interesting reasons to go "baseband". Although we have made some substantial commitments to baseband converters I still have some reservations. These are some of the potential problems:-

Setting and maintaining proper depth of modulation of the remodulated video carrier.

Setting and maintaining proper visual/aural intercarrier frequency.

Linearity of the remodulator. Most baseband converters use "game chips" - the low cost modulator chips developed for use in mass produced video games and low cost home computers. These modulator "chips" might not have adequate "linearity" for high quality entertainment video.

High cost of a very good IF/video demodulator section.

The use of a particular tuner/demodulator design forecloses any benefits from an improved tuner/demodulator which the subscriber might buy in the future. The displayed picture can not be any better than the baseband produced by the particular tuner/demodulator which the cable system provides. Heterodyne converters are not so limiting.

There are some advantages in a well-designed, well-made baseband converter:-

The IF and video demodulator provided in the baseband converter can be of better quality than that in the average subscriber's own TV set. Adjacent channel rejection could be improved. Proper synchronous demodulation could be provided.

Separate video output can be provided to bypass the internal remodulator. This direct video output can be used in "monitors" and VCR's.

High quality audio demodulation can be provided with separate baseband audio output to similarly bypass the remodulation process.

I believe that the problems of baseband converters are being overcome through intensive development and rapidly growing field experience.

WASTEFUL REDUNDANCY

There is a substantial redundancy in the present system of supplemental subscriber terminal devices provided by the cable system. The subscriber already has a tuner and many have sophisticated remote control systems. The cable system provides, and the subscriber has to pay for, an additional tuner and remote control system. The remote control on the cable system provided terminal is usually not as sophisticated as the remote control provided with the receiver. Sound and color cannot be controlled by most cable system terminal units and the subscriber then finds that he uses two separate remote control units to control one TV set - an obviously unsatisfactory situation. There are other problems which arise. Some remote control TV sets come back on tuned to channel 2 after being turned off. Cable system terminals frequently use channel 3 as their output channel requiring the TV set to be tuned to channel 3 to accept the output of the cable system terminal converter.

In addition to cost problems there are serious picture quality problems inherent in this duplicative system. There is additional signal processing, and sometimes demodulation and remodulation, to affect the quality of the picture which the subscriber finally views on his TV screen.

THE SHIFTING "DIVIDING LINE"

We are seeing at this time a "tug-of-war" between receiver manufacturers and cable systems as to where the dividing line of equipment ownership would be. Receiver manufacturers would like maximum ownership by subscribers, thus maximizing their own participation in the business of supplying this equipment. Cable system operators want the technical flexibility and the increased profit potential of supplying as much of the subscriber terminal equipment as possible. There is a growing interest among cable system operators in moving the subscriber terminal equipment outside the home so as to maintain better control of it. My personal opinion on this issue differs from that of many cable system engineers and operators.

There obviously has to be a change of interface. I don't think that anyone in the cable industry is willing yet to completely standardize the channeling of cable systems. The matter of cable tuning can best be handled by moving the interface from the subscriber tuner input to the demodulator output. Cable subscribers should be able to buy video/audio "monitors". Video/audio interfaces can be readily standardized. The standard input to the subscriber owned equipment should now be baseband composite video (with baseband audio) with RGB optional. Appropriate tuner/demodulators can be supplied by the cable system or could be purchased by the subscriber. Manufacturers could decide whether and which tuners they wish to make and sell. "Off-air" tuners could be offered, as well as tuners for the more popular cable channeling ranges and plans. Tuners might optionally offer RGB outputs as well as standard composite video baseband. New TV broadcast services with stereo audio would require new demodulators with baseband stereo audio output. Further extensions of cable system operating bandwidth would obsolete earlier tuners, but it would be cheaper for a subscriber to replace his tuner with a newer model than to replace the whole TV set just because of an inadequacy in tuning range. These tuners could alternativeely be provided by the cable system who could themselves purchase these units from various receiver manufacturers or from specialized manufacturers. Manufacturers of video devices such as VCR's, video disc systems, video games, home computers, etc. would also benefit since they could then feed the user's video/audio monitor directly, without an RF interface.

"Component" TV sets with separate "tuners" and "monitors" are now available from several manufacturers.

"OUTSIDE" CONVERTER/DESCRAMBLERS

Some cable system engineers would prefer to bring the "dividing line" out from the home and into the cable TV facility. The most commonly proposal is to move the tuning converter from the top-of-the-set outside to a nearby pole or to a utility room in a multiple dwelling unit. This is intended to give the cable operator better control over the converter and associated descrambling equipment since experience has shown that it is often difficult to retrieve this equipment from a subscriber whose service is suspended. This systems approach also gives better control over premium services since only the one channel selected by the viewer actually enters the home. Systems of this type have been demonstrated by at least three manufacturers (C-Cor, Thetacom, Times Wire & Cable) and are no doubt being considered by other manufacturers.

Alternative proposals have been made which delete or "jam" unauthorized premium services in terminal equipment outside the home and then feed only the "clear" channels into the home.

I am opposed to systems of this kind for several reasons:-

1. They place complex equipment in a hostile outside environment with consequent design and operating problems.

2. They are inevitably more costly than the present subscriber terminal equipment.

3. Their placement outside the home creates new maintenance access problems. The problem of maintaining additional equipment outside the home in hard to get to kiosks and/or pole mounted housings should not be underestimated. There is also a problem in providing power for these outside devices.

4. The required outside housings are bulky and create an aesthetic problem.

5. There is a serious problem with multi-set households. The systems being presently demonstrated require a separate drop line for each TV set in the home. There will no doubt be multiplexing of multiple outside converters and remote control links onto a single drop cable, but the requirement for multiple outside terminal equipment for multi-set households aggravates the previously cited problems.

6. These systems do nothing to solve the problem of the costly functional redundancy inherent in duplicating the tuning function in both the cable system and the subscriber's TV receiver.

There may be an interim role for these "outside" converters in apartment buildings where room can be found for the equipment and where environment, power, access and maintenance problems would be manageable.

This arrangement attempts to solve the cable system's main economic problem - control of PAY TV and other special services. Present technology and economic constraints compel the use of scrambling rather than coding techniques and virtually compel integration of the descrambler with a cable tuning device. The basic nature of scrambling requires firm cable system control (usually through ownership) of the descrambler and the development of "outside converter/descramblers" attempts to improve the cable system control of the descrambler.

A MORE SATISFACTORY SOLUTION

I believe that the most generally applicable and satisfactory solution is to move the cable/subscriber interface in the other direction - into the subscriber's receiver - by more realistically defining tuning range, selectivity, and RF field immunity for a "cable-ready" TV receiver and by defining a standardized coding and addressing system for controlling premium TV services. This would allow all the tuning and premium control functions to be owned by the subscriber as part the subscriber's own television receiver, while full control over premium services is retained by the cable system.

Let us distinguish between "scrambling" and "coding" of television signals. "Scrambling" merely modifies the signals so they cannot be received and/or displayed on a conventional TV receiver. Sync' suppression is a common form of scrambling. Video polarity inversion, FM transmission and "jamming signals" are other forms of scrambling. Knowledge of the technique allows "descrambling". You can build a descrambler that will work if you know the scrambling technique. Some systems use very sophisticated scrambling techniques that required more sophisticated descramblers, reducing considerably the risk that average individuals will reproduce or otherwise acquire the required descrambler. There is still very little protection from determined efforts to breach such a security system on a large scale. Another deficiency of such systems is the fact that mere possession of a descrambler often defeats the system. Some systems can address such "lost" descramblers "OFF", receiving some degree of protection, but there are still significant economic problems associated with the loss of descrambling equipment and the theft of services.

"Coding" modifies the signal in such a way that decoding needs both knowledge of the technique and the particular code or cypher that has been used to encode the signal. The technique is analogous to the encryption of high security message traffic. The coding techniques are usually digital but they do not always require digitizing the signal. Coding techniques have appeal because they would allow the subscriber to own the decoding equipment. Nationally standardized decoders could be built into new TV sets. We can then sell the subscriber the decoding equipment because it won't work until we sell him the code required to make the box work right. The code would be unique to a particular program service and to a particular subscriber decoder. We can change the code every day, every week, every month or for every program. The code supplied to the subscriber to operate the box won't work in his neighbor's box for the same program, nor will knowledge of the codes supplied to a large number of subscribers provide a decoding "key".

"Addressing" has been shown to be a very useful adjunct in subscriber terminal equipment. A nationally standardized addressing scheme would also be desirable.

SOME CODING TECHNIQUES

Several STV coding systems have been developed and demonstrated. One such system was developed at Electrohome under contract to Pay TV Corporation. The system inverts the video polarity of the signal in a pseudorandom line sequence, i.e. the number of scan lines in each polarity group is changed in a pseudorandom way. I was impressed with the effectiveness of coding as an alternative to scrambling, but I was not enthusiastic about alternating video polarity as a means of concealing the signal. I believe that there are too many problems in matching the "positive" and "negative" video channels in the decoder. The gain of the inverter must be closely controlled and problems of transmission linearity arise.

I have also seen demonstrations of "line shuffling". I believe that this technique is the most promising and very worthy of consideration as a national standard. Conventional video is read into a digital frame store in regular scan sequence. The lines are read out for transmission in a pseudo-random sequence. A similar store at the decoder reads in the lines as received and then, knowing the code, reads them out of the store in the proper sequence for display. The demonstrations that I saw (by Anderson Labs, a manufacture of digital frame stores), used a full frame digital store (525 lines of storage). This is obviously a very expensive system since decoding requires a similar store. I believe that a system using as few as 8 lines of storage would be adequate. I believe that the prospect for developing low cost consumer versions of such a decoder using either digital or analog storage is very good. "Professional users" could use digital storage for decoding. "Consumer users" could use lower cost CCD's or similar analog video storage devices.

Westinghouse has proposed a system which can be called "line dicing". This cuts a scan line into two parts and swaps the two parts in sequence. The "splice point" is moved along the line in a "pseudo random" fashion, effectively concealing the picture content. I'm not sure how well this works, because cutting a line in two and then rearranging the parts could create a bandwidth discontinuity at the "splice point". The advantage of such a system is that it requires much less buffer storage than a "line shuffling" system. A "line shuffling" system has normal bandwidth because the "switch points" are the beginnings of individual scan lines. Individual scan lines are not changed in any way but sequence.

It is quite practical to handle audio in digitized form, using available encrypting systems. I believe that a suitable digital system can be made to fit within the available aural subcarrier bandwidth without causing impairment of the video transmission. Digital audio transmission will benefit from the introduction of digital audio disc systems for consumers, expected within a year or two. This will make low cost digital audio "chips" available.

RECOMMENDATIONS

The cable system operating industry must go to "coding" instead of "scrambling". We must decide on a particular coding system as a national standard so that the decoders can be built into TV sets and so that low cost decoders can be made available to subscribers on a competitive basis. A nationally standardized addressing system is also important. I believe that subscriber terminal equipment is best made and distributed by the consumer electronics industry. Cable subscribers would enjoy a substantial benefit from a competitive market in subscriber terminal equipment. The beneficial experience with subscriber ownership of telephone terminal equipment has shown that a competitive market-place reduces costs to the user, increases variety and utility of equipment, and creates a wider opportunity for manufacturing and distribution enterpreneurship.

We now know enough about this technology to convene a national committee to recommend a national standard that could be used for satellite, STV and cable distribution. There might even be applications in other distribution technologies such as prerecorded videotapes and discs. One can also visualize more extensive use of program coding in television broadcasting. Some of the European broadcasting systems, e.g. the British Broadcasting Corporation, are completely financed by a compulsory "receiving licence". These broadcasting systems are in fact PAY TV systems operating on a substantial national scale. These systems might in future benefit from a standardized transmission coding and addressing system. One could also visualize public broadcasting in this country using coded transmissions as a means of financing their operations. Transmission coding of both video and audio is potentially as important a standard as is color coding. We must recognize the importance of such a standard and start the technical and organizational work required to develop and adopt national coding standards.

CONCLUSIONS

We don't want to buy, own, maintain and keep track of subscriber terminal equipment. Our company will be buying thirty million dollars worth of this equipment in the next three years. We believe that the public would be best served by technology which allows individual ownership of this terminal equipment. Our company would be best served by technology which allows us to conserve these capital and operating resources and use them for additional distribution plant and subscriber services.