EXTENDED BANDWIDTH CABLE COMMUNICATIONS SYSTEMS

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ABSTRACT:-

The need for extended bandwidth in cable communications systems is obvious. The rapid growth of cable systems in the U.S.A. is encouraging the proliferation of program services for cable distribution. The tree structured broad- band nature of cable systems means that capacity must be provided for all of the service to be distributed irrespective of relative popularity. Cable losses follow a square root of frequency law which makes bandwidth extension attractive as a means of increasing channel capacity. Reducing the number of amplifiers in cascade and the use of coherent carrier systems makes it possible for extended bandwidth cable systems to handle the additional channel loading with no more distortion than in present 35 channel systems.

THE NEED

The cable system constructed in any community will be, for practical purposes, the "only game in town". This system will have a "natural monopoly" on cable delivery of television and other services. As long as regulation and availability severely limited the number of services available there was no need for substantial increases in cable system capacity. Our earliest subscribers, in the 50's, were satisfied with five channel systems. Our very earliest subscribers had only three channels. System capacity was increased as technology, demand, regulation and availability of services all developed more or less simultaneously. Sometimes these developments were not all in step and one aspect of the service equation got ahead of the other. At this time technology has fallen slightly behind but can quickly catch up if we allow it to.

The very rapid recent growth of the broadband cable communications industry and the very apparant immediacy of substantial further growth in the number of cable TV subscribers is attracting a substantial number of additional service offerings. Further federal deregulation is in prospect. There are presently about 16 million cable subscribers in the U.S. This figure will at least double within three to five years. How many more "superstations" will be available for carriage? How many more PAY TV services of various kinds will seek a share of this immense new market? What kinds of brand new services will be developed in response to this huge market potential? How many channels will be required to serve purely local commercial and public access needs? How much system capacity will be needed for non-television services? How many channels will a cable television system need?

Three? Five? Twelve? Twenty? Thirty-five? Fifty-four?

Before we try to answer the question let us examine the basic nature of a cable system.

A cable system is like a water distribution system. We start from the purification plant and pump water out through water mains which spread out through the community. Pipes run up and down each street. Service pipes are run from the mains into each home that wants service. A water system delivers only one product - water. A cable system uses a single pipe to deliver a large number of separate and distinct products (services) simultaneously. The cable services are separated by operating each on a different frequency (channel). The various channels are like the keys on a piano, each with a different pitch (tone) and all being played at the same time. The cable subscriber selects the desired service by selectively tuning the desired channel from all the channels and services which are simultaneously presented to his receiver.

<u>All of the services on the cable are delivered into the subscriber's home whether he wants them all or not</u> (with some minor technical exceptions). Even in systems which do control to some extent what services actually go into the subscriber's home the control is right outside the home - all the services are present in the distribution cables. The subscriber makes his choice by

tuning the desired channel. Some systems may restrict the number of channels the subscriber can tune by means of special tuning converters or the system may restrict certain channels from entering the subscriber's home. The cable distribution system, however, carries all the channels that subscribers will get. The range and variety of services available to any subscriber is determined and limited by the carrying capacity of the cable distribution system. An individual subscriber may get fewer than the full number of channels and services available in the cable distribution system, but he can never get more.

The need for system capacity is therefore not related to the service tastes or desires of any individual subscriber. We must deal with the aggregate of all subscribers. If we are to provide a specialized channel of interest to only 1% of all the potential subscribers we occupy a channel throughout the whole system. It does not alleviate the systems capacity "crunch" to say that most subscribers will not use a particular service. As long as we feel obliged to provide it to even one subscriber we must occupy a channel throughout the whole system. We have no means of selectively delivering a service to one subscriber without impacting on our capacity to deliver other services to other subscribers.

It is wrong, therefore, to say that we need not expand our system capacity because the additional channels will have minimal utilization. Such a restriction reduces our ability to serve the few subscribers who do want to receive the additional less popular services.

Cable television has been hailed as "the television of abundance". System capacity could be increased by replicating the cable system - using dual or triple cables to multiply system capacity and costs. This expansion by replication of cables could go on indefinitely. There must, however, be some kind of limitation on the capacity we provide, since system capacity is not without cost. The limit is set by consideration of cost/benefit relationships. We believe that extending the bandwidth and hence the capacity of the present single coaxial cable system is an extremely beneficial cost/benefit trade-off. The cost increment is small - less than 15% in capital cost and negligible increase in operating cost. The benefit is substantial - an almost 50% increase in channel capacity!

HOW?

The bandwidth of a coaxial cable is virtually unlimited. Coaxial cables are routinely used by cable systems in connection with satellite receiving stations at frequencies of 4,000 MHz (ten times the 400 MHz frequency we are presently proposing). We are extending the usefull bandwidth of the cables we use from the present 300 MHz up to 400 MHz. The practical limitation on the operating bandwidth of the coaxial cable in our systems is the "loss" or attenuation of the cable. The cable dissipates some of the energy of the signals travelling it. Higher frequency signals are dissipated to a greater degree than lower frequency signals. The signals in the cable must be reamplified periodically before they are reduced to so low a level that they are intolerably affected by the intrinsic "noise" of the system. The usual present practice is to reamplify signals after about 20 decibels (dB) of loss. A dissipation (loss) of 20 dB means that the signal has been reduced to 1/100 of its original power. The amplifier then restores the signal to its original power by applying 20 dB (100 times) of power gain. Amplifiers apply less gain to lower frequency signals since the low frequency signals have suffered less attenuation than higher frequency signals.

Systems with nominal 35 channel capacity use frequencies in the 50-300 MHz range. A high quality coaxial cable used for main line purposes will typically have an attenuation of about 0.36 dB/100' at 50 MHz and 0.84 dB/100' at 300 MHz. Since the repeater amplifiers will be inserted after 20 dB of loss at the highest frequency used (300 MHz) the cable length between repeater amplifiers would be

20X100/0.84 = 2,380 feet.

Cable losses do not increase linearly with frequency, i.e. if we double the frequency we do not double the attenuation. Cable loss goes up by only the square root of 2 (1.414) if we double the frequency. If we go from 300 MHz to 400 MHz we do not increase cable loss by 400/300. Cable loss increases by the square root of 400/300 = 1.155. The actual measurement on the cable cited above is 0.98dB/100' at 400 MHz an increase of 16% which is very close to the predicted loss. The amplifiers previously spaced at 2,380 feet now have to be spaced at

20X100/0.98 = 2,040 feet

Amplifiers are thus approximately 15% closer together so we will need about 15% more amplifiers to cover the same area with a 400 MHz capacity system as we did with 300 MHz system. Alternately we may use lower loss cables than have customarily been used. Lower loss cables can restore the previous 300 MHz amplifier spacing situation. The additional 100 MHz represents 16 additional TV channels, and increase of almost 50% over the previously available 35 channels.

It is obvious that a further 100 MHz extension to 500 MHz would add 16 more TV channels with only 30% more amplifiers (each TV channel occupies 6 MHz of spectrum). We would have almost doubled system capacity with only a 30% increase in the number of amplifiers.

WHERE SHOULD THE BANDWIDTH EXTENSION STOP?

If amplifiers were perfect we wouldn't stop. We could go on to 1,000 MHz and beyond. A 1,000 MHz system would carry about 160 TV channels or equivalent other services. The cable loss at 1,000 MHz would be about 1.55 dB/100' and amplifiers would be spaced about 1,300 feet apart, not an impractical proposition. Many European cable systems do indeed operate at frequencies up to 900 MHz, but with very few operating channels, usually less than ten, spread across the available cable system spectrum.

The main problem is the imperfection and limitations of present amplifiers. An amplifier can handle only a limited total power of the signals passing through it. Each individual channel requires a certain minimum power to keep it comfortably above the "noise" of the system. Signals which are less than 40 dB (10,000 times) above the power of the noise of the system appear to have perceptible "snow". As we add channels we increase the total signal power to be handled by the amplifier. As total signal power goes up the amplifier begins to perceptibly distort the signal passing through it making them unacceptable to the subscriber. This distortion usually shows up as unacceptable interference bars and patterns across the screen. Since we pass the signal through many amplifiers between source and subscriber the distortion in each individual amplifier must be kept very, very small, so that the cumulative distortion after passing through many amplifiers is acceptably low. If we decrease signal levels to reduce distortion we risk excessive noise in the pictures. Some older systems use as many as fifty amplifiers between source and the furthest subscriber. Most present generation 300 MHz/ 35 channel systems limit the number of amplifiers in cascade to about 25. We are familiar with the amount of distortion that can be produced by a single "high fi" music amplifier. Imagine the cumulative distortion produced if we repeated the music through 25 such amplifiers in succession! The specification for the distortion in a typical cable TV amplifier is about -90 dB. This says that the power of the distortion product is about 0.0000001% of the power of a single TV signal at normal operating level. Compare this with the specification of your home "high-fi" amplifier.

The problem to be solved in expanding the number of channels in a cable system is not the bandwidth of the system. The problem is improving the capability of the amplifiers to handle the increased channel loading without creating intolerable distortion.

I was an early proponent of significant cable system bandwidth extension. Prior proposals had been made for marginal bandwidth extension by "tweaking" 300 MHz amplifiers to reach 320 MHz. I was prepared to extend bandwidth to a more significant degree by proposing a new upper limit of at least 400 MHz. The "square root" law is very tempting, but I felt constrained by a requirement for credibility and confidence in the upper frequency limit which could be reached at an early date and without requiring major amplifier or hybrid redesign. I was also constrained by my personal view of the additional channel loading that I could confidently undertake. My resolution of these constraints was 400 MHz.

I believe that I would undertake a further 100 or 200 MHz extension with 16 or 33 further additional channels after some experience with 400 MHz systems and a further appraisal of potential new developments in the solid state amplifier devices available for cable TV amplifier use. I expect that wider bandwidth systems could be implemented about two years from now.

Some TV receiver mnanufacturers have indicated that 400 MHz would be a convenient upper frequency limit for them. Some of them are deisgning new varactor tuners that would tune the entire cable TV spectrum plus the UHF-TV band. These new tuners would be double conversion designs with a high first IF. A first IF somewhere between 400 and 470 MHz would be convenient, to allow tuning of these two major bands (the

VHF-TV broadcast band would be a sub-part of the cable TV spectrum). Limiting the cable spectrum at about 400 MHz would therefore be convenient for these tuner designers. The cable TV industry would probably not accept such a restraint. The potential impasse might be resolved by using the 400-470 MHz cable spectrum for non-TV uses and beginning TV utilization again at 470 MHz (corresponding to the UHF-TV band).

HOW DO WE HANDLE THE AMPLIFIER LOADING PROBLEM?

1. We reduce the number of amplifiers in cascade.

Our present design specification is that 80% of our subscribers will be served by no more than 8 trunk amplifiers, one bridger amplifier and two line extender amplifiers in cascade. The maximum amplifier cascade to any subscriber will be 12 trunk amplifiers, one bridger and two line exten- ders. Although the distortion introduced in each amplifier may be somewhat greater with the additional loading, the total cumulative distortion will be no greater than that in present 25-35 cascaded amplifier systems operating with fewer channels.

These individually smaller distribution systems are fed from "hubs" near the center of each service area. We try to design the reduced service areas and the hub locations to coincide with generally accepted neighborhood or local political boundaries. We have been using the concept of hubs and reduced cascade lengths for at least five years to improve the performance of 300 MHz/35 channel systems which we were building. The improvements in system performance, reliability and maintainability are proven and substantial. The concept may be extended to 400 Mhz/54 channel system design with considerable confidence and experience.

The hubs are connected to a "master head-end" by means of a "transparant" multichannel signal transportation system. Alternately we may replicate most of the "master head-end" at each hub. In most cases we choose a multi- channel microwave system provided by Hughes Microwave Products, called "AML" (Amplitude Modulated Link). This microwave system provides multi-channel transmission in the 12.7 - 13.2 GHz band. It is very effective over distances up to 12 miles. It can be used over greater distances with a small compromise in transmission reliability. These microwave systems are "transparant" in that they contribute no significant noise or distortion to the channels being carried. The use of AML allows large areas to be provided with high quality expanded capacity service by breaking the area down into smaller service areas interconnected with the "master head-end". There is more than ten years of experience with AML transmission systesm in several hundred installations. AML systems are very reliable, usually more reliable than the long "super- trunk" cable transportation systems that they replace.

In situations in which AML systems cannot be used or are undesirable, special "supertrunk" systems using FM transmission, feed-forward amplifiers, or optical fiber transmission could be used.

We minimize the effect of increased cable attenuation at 400 MHz by using cables with lower attenuation than those which are commonly used. We prefer "fused disc" cable manufactured by General Cable. This cable uses air as the dielectric - the space between the inner conductor and the outer sheath. This cable has about 15% lower loss than the foamed polythylene plastic types commonly used in 300 MHz/35 channel systems. The following table compares the two types of cable:-

3/4" trunk cable

Maximum Loss dB/100' at 68 deg F

Freq.	COMMSCOPE PIII+ (foamed plastic)	GC FUSED DISC III (air dielectric)
300 MHz	0.90	0.80
400 MHz	1.05	0.93

The 13% improvement offered by the fused disc type cable makes up for the 15% closer amplifier spacing that might otherwise be required. The fused disc cable has about the same loss at 400 MHz as the more conventional foamed polyethylene cables do at 300 MHz.

2. The use of improved transmission technology, specifically harmonically related coherent carrier systems (HRC).

The individual channels in the cable system may be compared to the keys of a piano. The low channel numbers correspond to low frequency or pitch, the higher channel numbers corresponding to higher pitched keys. The channels on a cable system are not "tuned" with any particular care or regard to their interaction with each other. All the channels "play" at the same time, like a great 35 note chord. If the channels are not all in proper "tune" the resulting "dissonance" due to amplifier distortion is very annoying. In an HRC system the channels are all in "perfect tune" having a simple harmonic relationship to each other. There is no "dissonance" when they all "play" together and the impact of amplifier distortion is significantly reduced. The benefit of HRC is real and substantial - so substantial that a 54 channel HRC system will "play" as well as a 35 channel conventional system.

Extensive testing of coherent carrier systems has shown that they allow at least 5 dB higher operating levels with the same distortion levels as experienced with non- coherent carrier systems. Alternately they create reduced distortion at the lower operating levels. The effect is to allow amplifiers to handle the additional channels without any more distortion than when 35 channels are handled in a non-coherent system.

3. <u>By having additional transmission techniques in reserve for future further improvement of system performance</u>.

More than five years ago we published papers describing the technical limitations on cable system performance and outlining the techniques available for improving system performance. One of the techniques described but dismissed at that time (NCTA convention, May, 1972) as costing too much money was "video synchronization". This technique is now affordable in large systems. It would add about $400,000 to the cost of a large system master head- end - a substantial sum of money but considerably less than the $1.5 million that the technique would have cost five years ago. Drastic reductions in the cost of digital technology has reduced the price of video synchronizers. The cost may drop still further as the cost of digital memory is further reduced. Digital frame synchronizers that cost $25,000 per channel a year ago are now available at $12,000 per channel.

Synchronizing pulses define the "edges" of the TV picture. They are the "black frame" around the picture but masked from view by the frame of the TV set. These synchronizing pulses are the highest power part of the the TV transmission. If we synchronize the sync' pulses on <u>all</u> the channels we have the power peaks occuring simultaneously on all the channels. The worst amplifier distortion occurs during the synchronizing pulses and affects all the channels being carried. If these synchronizing pulse peaks occur on all channels simultaneously the worst distortion occurs in the part of the picture which is the "black" frame, out of sight at the edges of the screen. The effect is as though system operating levels were reduced by 2.5 dB. This technique is still expensive, but now affordable in large systems.

<u>WHEN</u>?

<u>CABLE</u>:-

Now!

We tested available cables more than two years ago. Every one of ten reels of main line trunk and distribution cable tested (foam-dielectric type) had acceptable characteristics beyond 400 MHz. Since that time COMMSCOPE, one of the leading manufacturers of foam-dielectric type cables, has announced the general availability of cable specified and guaranteed to 450 MHz (COMMSCOPE PIII+).

We tested General Cable's fused disc type cable and found that the cable was acceptable except for a narrow frequency band around 308 MHz. General Cable has modified their manufacturing process to overcome this deficiency and is now delivering fused disc cable specified and guaranted to 400 MHz. General Cable is the largest American producer of telecommunications cable after Western Electric.

We have tested a number of reels of our preferred service drop cable and have found that the performance to 400 MHz is quite acceptable - a normal extrapolation of the present performance at 300 MHz. We have negotiated with the manufacturer to obtain a guaranteed specification to 400 MHz for cable TV service drop use.

We prefer the fused disc cable for trunk and distribution use in larger 400 MHz systems because of the low loss and the improved characteristics at 400 MHz. The higher loss foamed-dielectric cable would be quite acceptable in smaller systems.

Air-core cables become more attractive at higher frequencies because the foam-dielectric cable departs somewhat from the square root law at higher frequencies. The foamed-dielectric cables are higher in loss at 400 MHz than the square root attenuation law predicts. Similarly we prefer foamed-dielectric drop cables at 400 MHz even though we have usually used solid-dielectric drop cables at lower frequencies. The foamed-dielectric has a greater air content than the solid-plastic dielectric and hence has more attractive attenuation characteristics at higher frequencies.

Various other air dielectric cable constructions are possible. We have no doubt that other cable manufacturers will soon announce alternative air core cables for cable TV application.

AMPLIFIERS:-

Very soon!

We have assurance of amplifier supply from at least three major manufacturers - Jerrold, Scientific-Atlanta (S-A) and Texscan-Thetacom. Jerrold and S-A have made public announcements to that effect. Both have accepted orders for 400 MHz systems. S-A and Thetacom have assurances from Motorola that thin film hybrid amplifier modules (the electronic heart of a cable amplifier) are available. Thetacom has accepted orders for 400 MHz line extender amplifiers for May delivery. Jerrold has actually shipped some 400 MHz amplifiers and initial deliveries from S-A are expected within a few weeks.

Motorola recently announced (1980 February 05) that 400 MHz hybrids (a pair of 17 dB gain blocks) were indeed in production. Parts numbers, prices and detailed specifications have been provided to amplifier manufacturers. A 34 dB "hybrid" gain block (used by some manufacturers in line-extenders) is in development and will be available in about six months. Motorola's spokesman said that the new hybrids had improved characteristics yet retained all the reliability features of the 300 MHz versions. The new 400 MHz hybrids have better characteristics at 300 MHz than the previous 300 MHz versions. He said that there was no "bad news" associated with the introduction of the new 400 MHz hybrids. The new hybrids are priced about $10 higher than the 300 MHz versions at this time. TRW announced, at the same meeting, that they would make similar product production announcements within a few weeks. Motorola and TRW are the sole suppliers of thin film hybrids to the industry. Both manufacturers now have facilities for testing and checking the specifications of hybrids to 400 MHz with up to 54 channels of loading.

S-A and Thetacom are now confident of 400 MHz hybrid supply from Motorola and are moving toward 400 MHz amplifier delivery. We have been promised early delivery of trunk, bridger and line-extender amplifiers from S-A beginning in June, and line extenders from Thetacom beginning in May. Jerrold uses its own "thick film hybrids" in one of its amplifier lines and found that it could upgrade this particular amplifier to 400 MHz operation with its own technical resources and without any wait for delivery of 400 MHz thin film hybrids. The remainder of Jerrold's amplifier line will be upgraded to 400 MHz as soon as Motorola and TRW make the necessary hybrids available (later this year).

All three of these manufacturers have checked the detail of their amplifiers and associated passive devices (splitters, taps, connectors, etc). Some changes are necessary. Power passing filters have been redesigned to operate past 400 MHz. Equalizers and automatic gain and slope control circuits have been redesigned. One minor compromise seemed general. It may be necessary to restrict the up-stream return path to the 10-35 MHz band instead of the usual 5-35 MHz band. This eases the frequency extension to 400 MHz since a full octave (5-10 MHz) of bandwidth has been removed at the low end in favour of a partial octave (300-400 MHz) 100 Mhz bandwidth extension at the upper end. This is an acceptable trade-off. Subsequent development will probably restore the 5-10 MHz spectrum.

We confidently expect that additional amplifier manufacturers will announce and/or show 400 MHz amplifier equipment at the National Cable Television Association (NCTA) convention in Dallas, in May.

Passives (splitters, directional couplers, subscriber taps, power-inserters, etc.) have been no great problem. We have checked the characteristics of many manufacturers' types and have found them to be acceptable or easily modified. The change of specification range from 5-300 MHz up to 10-400 MHz has eased the problem since the ferrite material commonly used in such devices can be chosen for higher frequency use without concern for tight specification at lower frequencies (below 10 MHz). The current boom in the cable system equipment business has attracted sveral new suppliers who are designing devices with attractive specifications past 400 MHz. A number of these new lines will be shown at the NCTA convention in May with deliveries availabe immediately afterwards. These lines include power dividers, directional couplers, power-inserters, subscriber multi-taps, subscriber splitters and baluns.

The 400 MHz amplifier hybrids use no more electric power than the 300 MHz versions. There is no greater heat dissipation problem or power feed problem than with 300 MHz amplifiers. Hybrids have traditionally been operated with greater amounts of current and heat dissipation as greater channel loadings were imposed on them. We are using other means to accomodate the extra channel loading and we are not increasing the current and heat dissipation of the hybrids in our 400 MH amplifiers. A few more amplifiers might be used so that as much as 15% more power might be required. The use of air-core (fused disc) cable instead of foamed dielectric cable makes up the difference in amplifier numbers if power feed and amplifier number is a concern.

The air core cables which we prefer have a larger center conductor and hence reduced ohmic losses for cable power distribution. Cable power distribution is significantly more efficient with these air dielectric cables than with comparable size foamed dielectric cables.

We are using 400 MHz amplifiers with the same gain at 400 MHz that similar amplifiers previously had at 300 MHz. Reduced amplifier gain has sometimes been used as a means of handling additional channel loading and/or reducing amplifier distortion. We are using reduced cascade lengths (12 trunk amplifiers) and improved transmission technology (HRC) to handle the amplifier loading and distortion problems.

CONNECTORS:-

Now!

We have tested cable splice connectors and find them quite satisfactory up to frequenices beyond 400 MHz. The amplifier and passives manufacturers supplying our requirements have tested the connectors associated with their products and have found them to be satisfactory with few exceptions. Acceptable connectors are certainly available to replace any connectors that have unacceptable deficiencies at 400 MHz.

CONVERTERS:-

Soon!

Even 300 MHz/35 channel systems require the subscriber to have a supplemental tuning converter to tune all the channels. A 400 MHz/54 channel system certainly requires the use of subscriber converters. S-A has developed an all new digitally tuned 400 MHz/54 channel converter, including the RF tuner section. Deliveries will start in the middle of this year. Jerrold has announced a new digitally tuned "cordless" 400 Mhz/54 channel converter which will be shown at the May NCTA convention. Deliveries will commence soon afterward. Lindsay will show "cordless" 400 Mhz/54 channel converters at the NCTA convention with deliveries to start a little later in the year. GTE/Sylvania has indicated that a 400 MHz version of their popular digitally tuned converter will be announced at the May, 1980, NCTA convention. Oak will make a similar announcement at the convention. By December of 1980, when large quantities of converters will be required, they will be available in several models and from several sources.

Converters for 400 Mhz/54 channel operation will probably all have "digital" keyboards for tuning selection. Mechanical slider, push-button or rotary switches become ungainly when 50 or more tuning selections are required. Digitally controlled converters have been available from GTE/Sylvania for almost two years in a 40 channel version. Their practicality has been proven by large scale production and acceptance of the GTE/Sylvania version. The new 400 MHz/ 54 channel converters are patterned after the techniques and devices proven in the GTE/ Sylvania model. These converters make extensive use of digital integrated circuits including a microprocessor to offer additional convenience features with small increase in cost. The digitally tuned GTE/Sylvania model has enjoyed great acceptance and popularity in new 35 channel systems.

The ability of converters to handle additional channel loading is similar to that of system amplifiers. The converters are broad band electronic devices which are subject to signal distortion if overloaded. The use of coherent carrier systems (HRC) benefits the converter in the same way as the system amplifier. 400 MHz converters will not require "preselection" to reduce the loading burden on the mixer stage. Coherent carrier systems allow greater channel loading than non-coherent systems. This is borne out by years of experience with tens of thousands of converters in those present 300 MHz/35 channel systems which now use harmonically related carrier technology.

TEST EQUIPMENT

Now!

Laboratory equipment presently has the bandwidth to work with 400 MHz systems. We have spectrum analyzers, tracking generators, frequency counters, etc. from manufacturers such as Hewlett-Packard and Tektronix which operate to 1500 MHz and more. Our more routine system test equipment such as sweep generators and return loss bridges have had 400 and 500 MHz capacity for several years. As an example the Wavetek 1801A CATV sweep generator with 1-500 MHz range has been available since mid 1975. Much of our equipment is routinely purchased with frequency range to 1,000 MHz in order to deal with UHF receiving equipment. This equipment is presently available from experienced cable system test equipment suppliers such as Wavetek and Texscscan. Texscan has undertaken to extend their popular test equipment line, including signal level meters, to at least 400 MHz. Mid-State Electronics has also undertaken to extend the frequency range of their popular test equipment, including signal level meters, to 400 MHz. We have quantities of 400 MHz signal level meters on order from several manufacturersd for July, 1980 delivery.

PAY TV CONTROL EQUIPMENT

Now!

"Negative" trap equipment requires checking and verification of performance to 400 MHz. All of the present manufacturers of such traps are actively bidding on our requirements for 400 MHz systems already under onstruction and suitable negative traps have been ordered from at least one such supplier (VITEK) for new 400 MHz systems under construction in the Detroit area.

Some "positive" trap systems require redesign for 400 MHz.

The operating channels for both types of "trap" systems are chosen to be moderately low in frequency, even in present 300 MHz/35 channel systems. The choice of channels for the "VITEK" type negative trap, which has "third harmonic response", must take into account the system bandwidth expansion to 400 MHz. We have worked out the channeling problem with VITEK and have assurances of immediate availability of suitable traps for use in 400 MHz systems.

"Descramblers" are usually associated with converters. Both Jerrold and Scientific-Atlanta have offered their descrambler systems associated with their new 54 channel/400 MHz converters and operable on all channels right up through 400 MHz.

AML MICROWAVE EQUIPMENT

Soon!

Hughes is completing the modifications necessary to modify their AML system to accomodate input channels up to 400 MHz. They have accepted our order for additional channels in the 300-400 MHz range to be "bolted on" to 300 MHz equipment delivered earlier. The 300-400 MHz add-ons are scheduled for December of this year. Hughes advises us that no special problems have been encountered and they are confident of meeting their December delivery commitment.

RETROFITTING

No!

We do not recommend retrofitting older systems to 400 MHz/54 channel operation, and we have no plans to do so. Older systems which we wish to upgrade to 400 MHz operation will probably require complete rebuild with subscribers cut over to the new plant in an orderly fashion as the new distribution system is activated and the old plant retired. Many older systems require new service drops as the older drops were generally single-shield copper-braid cables. These single-shield drops do not provide adequate shielding even in 300 MHz/35 channel systems. We have found in general that older twelve and twenty channel systems require extensive rebuild even when upgrade to 300 Mhz/35 channel operation is desired.