THE HIDDEN COSTS OF 400 MHZ

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ABSTRACT

Cable television (CATV) has already suffered through too many premature technological developments. We do not need any more fiascos like the early transistor amplifiers, or strip-braid and styrafoam cable. Expanded bandwidth is now being promised in fanciful franchise proposals before it is ready, with unrealistic system design and gross lack of awareness of either the costs or the difficulties. The crash program to provide more channels appears to be a repetition of the automobile industry's horsepower race, now seem as disastrous. The effort is diverting our attention from the scandalous inefficiency of use of the channels we already have, such as spreading the information content of a 4 kHz news wire over 24 MHz of cable spectrum. We need to improve our product; we need to recognize that more is not necessarily better.

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I have long maintained that engineers can do anything, given proper motivation, and enough money. We can fly to the moon; and believe it or not, we can board an airplane in Paris after sunset and deplane in New York before sunset the same day. But even though we can do these things, we need to consider whether doing them is a good idea. I doubt that regular flights to the moon will soon be scheduled, just because we can do it; and the reports are that the supersonic airplane has been a commercial disaster. I have no doubt whatsoever that we can build 400 MHz or 500 MHz systems, or whatever and make them work. I am concerned about the costs, in dollars as well as less tangible assets, and whether the true costs are really justified.

My concerns fall in two categories: the short term; and the long term.

For the short term, I would remind you of the disastrous use of the first available transistor amplifier in Great Falls, Montana. The entire manufacturer's engineering department was unable to make them function properly with cascades of more than 8 or 10 stations. After a great deal of promotional ballyhoo, Teleprompter had to admit failure, and rebuild with tube equipment, at considerable expense and embarrassment.

Then there was that great, wonderful, new kind of cable, called "strip braid." The only way you could keep the high band going was to beat it with a baseball bat to break up the corrosion at the crossovers.

And then we had the Starline One transistor problem, which may still be in litigation against RCA for all I know. The laboratory models were great, but a weld in the output transistor kept failing in the field.

Do I dare mention styrafoam cable; or fuse blowing in the first edition of the Channel Commander II; or 45 MHz IF converters; or a host of other major and minor technological disasters?

Our industry has had a terrible habit of field testing new equipment on unsuspecting, and often unhappy customers. We don't need any more strip braid fiascos, but I am afraid we may be headed in that direction by promising the cities to deliver 54 channels with equipment that has not yet even been produced, let alone subjected to operational experience in the field.

Not only that; but now we are trampling all over each other to offer dual 54 channel cables, after first arguing that the expanded band single cable is more cost effective than dual 300 MHz cables. Who will be first to offer a triple 440 MHz system with 180 channels?

As a matter of fact, the short range problems I have worried about may not even happen. I rather suspect that most of the 400 MHz series of amplifiers may never actually carry 51 or 52 or 53 or 54 channels. The fancy proposals proclaiming the

desparate need for 50 or 90 or 120 channels call for 15 or 20 access channels, most of which will be dark most of the time; 10 or a dozen channels for "future use"; several channels for proposed satellite services that have not yet started, or are available for only a few hours a week. When the system is actually constructed, it will likely be required to carry only 30-35 channels at the most. With HRC and conservative spacing, the systems will probably work well.

When a real need develops for 50 or more channels, however, it may be necessary to drop the levels and degrade the carrier-to-noise ratio by a few dB to get rid of cross-mod; or redesign the hub interconnect; or a lot of other costly changes.

In the long run, I am more concerned about a lot of hidden costs that are not being taken into consideration.

The Dallases, Houstons, Cincinnatis, Pittsburghs, in fact all major markets require a quality of performance and reliability of service which we have mostly only talked about in our self-serving advertising in conventional underserved markets: "studio quality pictures"; "perfect TV"; "snow-free reception"; "ghost free television"; and so on. In my opinion, we are going to have to produce and maintain 45 or 46 dB carrier-to-noise ratio and the equivalent of 53 dB carrier-to-composite-triple beat ratio (non phase-locked C.W.) at the end of the line, including satellite and microwave relay, hub interconnect, and upstream carriage from the most remote origination source; and all this at any temperature between the normal maximum and normal minimum for the area.

This is tough, even with 30 channels. I am afraid that few systems, present or proposed, could honestly comply with such standards today. With 40 channels, it will be twice as tough; with 50 channels, probably four times as tough; and with 70 channels, it could be eight times as tough, or even more. This is merely because of the enormous build-up of triple beat products.

In their seminar several weeks ago, Jerrold used a goal of 45 dB CNR for a comparison of the cost of hypothetical 400 MHz and 300 MHz plants. The best we can expect of a hub interconnect system is that it reduce CNR by no more than 1 dB. So, in order to achieve my goal of 46 dB overall, the hub distribution system would have to be designed for 47 dB, not 45 dB. Jerrold based its analysis on the assumption that noise figure is only 1 dB greater at 400 MHz than at 300 MHz; but their SJS spec sheet shows a 2 dB degradation. Jerrold assumed 6 dB improvement for ICC phase-lock. Published data suggests that with 27 channels cross-modulation can be reduced at least 6 dB by optimum phase adjustment (phase phiddling) of the HRC carriers. I know of no published work on the subjective improvement due to HRC without phase adjustment. The unpublished information is that the improvement is 4 to 6 dB. Since only half as many offending beats are coherent with ICC, as with HRC, it would appear safer to count on only 4 dB improvement with ICC. As far as I know, no one, including Switzer, has proposed to take advantage of "phase phiddling."

If all these adjustments are made, the maximum trunk cascade allowable reduces from 25 down to 14. Switzer is probably on the right track to limit the maximum 400 MHz cascade to 12 amplifiers.

I am very much concerned that so many people, in the cities and in the industry, are being led to believe that cascades can be even longer with the 400 MHz amplifiers than with 300 MHz. We will either face a rude awakening one day, or we will not be able to fullfill our promise to carry 50 plus channels. I call this a costly hidden danger.

How many hubs do you need for a 1500 mile plant with maximum cascade of 12 distribution trunk amplifiers? How long will the hub interconnect routes be? I don't know, but I suspect that there will be some 10-15 mile routes, or longer. To achieve 46 dB CNR overall, with 47 dB distribution, the interconnect CNR would have to be at least 53 dB. A 54-channel cable, 15 miles long, would require losses of only 0.14 dB per 100 feet at 400 MHz. You could almost make it with 5-inch air dielectric Heliax at $25 a foot; $2 million for 15 miles! Forget it.

AML seems to be the most popular answer. It works; it will achieve 53 dB C/N; and the price is reasonable. But do your customers take kindly to rainfall fades during a premium movie, or a critical game? Multi-path fading outages increase roughly according to the cube of the path length, for paths longer than about 6 or 7 miles. In regions where atmospheric inversions are rare, and the climate is never very hot or humid, a 10-15 mile AML path is probably no problem. But I have been places where the customers were so angry about microwave fading they were ready to do violence. This is a hidden cost which can't be expressed in dollars alone.

AML is a one-way facility. In order to accomplish all the wonderful two-way services promised in most proposals, you will probably have to construct a return cable between the hubs anyway. The CNR on this cable figures in the overall picture delivered, for example, from a school studio in one hub area to subscribers at the extremity of another.

Since you will need a cable for return anyway, and since AML has some undesirable characteristics, the best answer may be FM cable, or perhaps a combination of AML and FM cable. But remember that each FM channel requires 14 MHz, so that at least two cables will be required for 50 channels downstream; and a third for upstream. The modulator/demodulator pair for each channel costs about $3250 for one line. Another set of demodulators is required for each additional hub, at $1800 per channel. This is a hidden cost, if in fact, Catel and Tomco can produce them fast enough to supply the demand.

It is probably fair to note that not all of the hub interconnect expense should be allocated to the 54-channel design; and, in any case, the hub interconnect probably represents no more than 5% to 10% of the total capital cost. Nevertheless, a lot of small increases can add up to a fairly substantial overall increase.

And there are other hidden costs that cannot be measured in dollars alone.

The beats due to ingress from strong local TV stations are at least 15 dB worse with HRC than they would be if the cable carriers were phase-locked to the TV stations. Unfortunately, it also just happens that 1.25 MHz is the very portion of the video band in which beats are most visible. Customer complaints are probably the most sensitive detectors of such ingress. Much more careful maintenance is required with HRC in strong local fields. This is a hidden cost.

The amount of subjective improvement in triple beat interference possible with phase-locked carriers is limited by cross-modulation. It is a curious situation that a proposal to reduce the composite triple beat standard to 43 dB, when the carriers are phase-locked, should be made at the same time as the announcement that cross-modulation would no longer be specified in data sheets. Since a phase-locked system is actually cross-modulation limited, it would seem important not to ignore cross-modulation.

Switzer proposes to use a $20,000 synchronizer on off-air channels, and gen-lock on locally originated channels, so that all sync pulses will occur during sweep blanking. This is a good idea, but it is another substantial addition to the cost of 54-channel carriage.

And then, what happens to captioning data, the VIRS color control signal, and encoded teletext data when we dump all the worst cross-modulation into the blanking interval? Is this another hidden penalty we will have to accept? And besides, Switzer is promoting the Tektronix ANSWER system to monitor VITS waveform. So what happens to that when the blanking interval is messed up with cross-mod?

I think of HRC as analagous to sweeping the dirt under a rug. As long as there is only a little dirt, it will never be noticed. But, if there is a lot of dirt, some nails, blocks of wood, and other junk, there could be quite a disturbance under the rug.

At 30 channels, we have a maximum of about 315 zero beat intermodulation products in the worst channel. At 54 channels, we have nearly 1000; at 70 channels, I suspect we may have several thousand. With harmonic carriers, these zero beats will be coherent, and their voltages will be additive. If single amplifier 3-tone triple beat is down 108 dB, the zero-beat voltage with 54 tones will be down only 48 dB (108-60=48 dB). If we cascade 25 of these amplifiers, with 54 harmonic carriers, the pile of dirt under the rug will be only 20 dB below the desired carrier (48-20 log 25 = 20 dB). If the coherent pile of dirt is steady, it will simply add 10% to the carrier voltage relative to the sidebands. That is to say, the modulation level and consequently the picture luminance will be reduced by 10%.

What if we find out, next year in Atlanta, or Dallas or Pittsburgh that cable TV pictures are slightly washed out, not quite as brilliant as they are when received directly? Moreover, since these zero beats are all constantly varying in magnitude with picture content, isn't the sum likely to fluctuate? Will we actually have pictures with fluttering luminance? Will AGC take care of this on all TV sets, or only some, depending on the time constant? Is this a tolerable hidden cost?

TV receiver designers have told me they are considerably dismayed by our non-standard HRC allocation plan. They have finally come around to the idea of marketing cable-ready TV sets so that a converter interface would not be necessary. But they have problems of compatability between standard and HRC

channelling, and are disturbed that we keep changing our plan. Although manual fine tuning is generally broad enough to encompass HRC channels, AFT will probably not have (and should not have) sufficient capture range. In fact, considering the Channels 5 and 6 anomaly, and the extra HRC channel between 4 and 5, the AFT design appears to be rather difficult. Moreover, the practice of including a special trap ahead of the mixer to keep the low end of the FM band from interfering with Channel 6 will actually knock out the sound on HRC-6 which falls at 88.5 MHz. It appears that widespread use of HRC may very well put an end to the development of cable-ready TV sets. I consider this a hidden cost of the 54-channel development.

I believe the desperate scramble for franchises has seriously diverted our innovative technological attention away from areas that could be more profitable and more meaningful in the long run than a crash program to expand amplifier carriage capacity to 50 or 70 or more channels.

For example, the extravagantly wasteful way in which we are presently proposing to use the information carrying capacity of our cable systems is simply scandalous. For example, many applications actually propose to use at least 4 channels, 24 MHz, to display on customer TV sets the infinitessimal information carrying capacity of a single 4 kHz news wire. All of the information contained in a 6 MHz alpha/numeric channel could be transmitted "piggy-back" during the vertical interval of a single TV channel without requiring any cable spectrum at all.

We should be developing improved premium channel security methods to more effectively keep ahead of the rip-off entrepreneurs.

Subscribers need a better way of sorting out even 35 channels, many of which are seldom if ever viewed. We need a better way to provide return transmissions. We need to develop and market information retrieval systems such as teletext. We need a multi-bird TVRO antenna.

If the new Motorola and TRW hybrids, either this year or in the near future, offer increased dynamic range for non-phase-locked carriers, the 400 MHz program will have valuable consequences almost incidental to the expanded bandwidth.

But to my way of thinking, the real and hidden costs of expanding to 54 channels on a single cable are hard to justify when compared with other methods of expanding channel capacity as needed.

As Pat Hawken of the British Independent Broadcasting Authority recently said in commentary on the IBA decision to use terrestrial microwave rather than satellite relay:

> "This is one illustration to show the danger of 'futurology' based solely on engineering and technology. Even if, in end, the best engineering solutions have a habit of winning through, it takes time to tango."

Back off, fellows. Let's be sensible.

The Concorde is an engineering triumph, but a commercial disaster.

The automobile industry is in a tailspin because they had their heads in the sand reading signs that said "big is better." Cable television had better take heed. More channels, like more horsepower, could lead us to disaster unless we have first maximized the quality of our service and the efficiency with which we can offer information and entertainment to our customers.