AN EQUIPMENT SCENARIO FOR DELIVERING STEREO SOUND ON CATV SYSTEMS

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ABSTRACT

NCTA studies indicate that off-air TV signals carrying stereo sound are likely to cause problems in certain CATV distribution equipment. To ignore this issue in a CATV plant may result in unacceptable picture and/or sound quality. This paper describes an alternative approach that permits delivering CATV stereo sound in a way that is advantageous to both the subscriber and the cable operator. The scenario is to simulcast stereo sound in a special off-channel frequency band. This approach permits the customer to receive stereo sound with conventional audio equipment rather than a special TV set, and is compatible with most existing set-top terminal equipment. In addition, this approach provides a systematic migration path from present CATV configurations to stereo delivery, and also could provide some attractive subscriber feature enhancements.

THE PROBLEM

It now appears almost certain that stereo sound TV signals will soon be broadcast by many TV stations. It is also likely that there will be some new problems for CATV operators when those signals start arriving at their off-air antennas. The NCTA has released a study on the proposed broadcast of stereo sound TV and its likely effects on CATV systems. Delivering stereo TV signals on cable as received off-the-air can cause several problems, including:

1. broadened audio spectrum may cause interference with upper adjacent channel video,
2. proposed stereo signal formats are likely to interfere with authorization coding that is presently transported on the audio carrier in some popular scrambling schemes,
3. reduced audio carrier level required in CATV systems could significantly compromise the quality of decoded stereo sound,
4. many present set-top terminals may not pass off-air stereo sound.

With the variety of equipment used today in head-ends, distribution, and set-top terminals, it is likely that even a small cable system operator will encounter at least one channel where direct carriage of off-air stereo sound causes subscriber dissatisfaction.

In addition, even if the cable operator is able to deliver stereo sound TV as it is broadcast, the subscriber may be forced to purchase a "stereo" TV to take advantage. The CATV operator needs to develop an equipment strategy that will permit delivering stereo sound in a way that is more attractive to the subscriber and at acceptable cost.

PROPOSED ALTERNATIVE

The proposed alternative is to simulcast, delivering two signals to the subscriber. One is the conventional TV signal incorporating monaural sound. This conventional TV signal is fully compatible with any TV set and will not suffer any of the potential problems cited in the NCTA study. This is the same signal that TV sets have always received. The other signal is the stereo sound signal which is carried 'off-channel' in a special frequency band dedicated to that service. There is considerable flexibility in delivering the stereo sound signal. One option would be to deliver it in the FM-broadcast band. This has the advantage that the subscriber needs no special equipment beyond what is likely to already exist in the home. Another means of delivering the stereo sound signal is to carry it in some special part of the cable spectrum that is presently unused. This method does result in a requirement for a special device ("stereo module") in the subscriber's home, but as will be

discussed, also promises to be low-cost, user-friendly, and can include special user convenience features. Either way, this alternative delivers to the subscriber stereo sound signals that are compatible with reasonably-priced audio equipment which in many homes, already exists.

WHAT IS NEEDED TO DELIVER OFF-CHANNEL STEREO SOUND

There are two basic things that must happen to deliver off-channel stereo sound. First, the stereo sound must be removed from the incoming signal at the headend and replaced with a monaural equivalent. This will require some additional equipment at the headend that will be discussed later. Second, the stereo sound must be delivered to the subscriber. That implies the need for some additional FM-stereo modulators at the headend and some receiving and audio equipment at the subscriber's home.

SUBSCRIBER'S VIEW OF DESIRED TERMINAL CHARACTERISTICS

The subscriber is sensitive to equipment cost, convenience, and compatibility with existing home entertainment equipment. The total cost of required terminal equipment should be significantly less than a new "stereo" TV. A subscriber "stereo module" that would deliver left and right stereo audio channels, including considerable user convenience features, might cost $50 in large production quantities. Many subscribers would already own a suitable amplifier and speakers. If not, purchase of dedicated stereo equipment might cost an additional $100. So the anticipated subscriber equipment cost would be very favorable compared with the cost of a new "stereo" TV set.

The subscriber would also favor user-friendly equipment. One option is simulcasting in the FM-broadcast band and have the subscriber use a conventional FM-stereo receiver. The problem here is that the subscriber has to get up and re-tune the stereo receiver each time the TV channel is changed. It would be far better to have a "stereo module" that automatically tunes to the audio program that corresponds with the channel being viewed on the TV set.

The subscriber would also be receptive to a hand-held remote control and any other user convenience features that could be incorporated at reasonable cost.

SOME DESIGN ALTERNATIVES FOR SUBSCRIBER TERMINAL EQUIPMENT

At least three concepts have been identified for implementing the subscriber equipment described above. In each case, the primary function of the subscriber terminal or "stereo module" is to tune to the appropriate stereo sound carrier frequency, detect the left and right (L and R) stereo components, and provide L and R audio outputs.

The first concept is diagramed in Figure 1. The drop feeds signal to both the existing converter and the stereo module. To satisfy the auto-tune requirement, each channel having a corresponding stereo audio program would carry a unique 'tag' that passes through the converter and is fed back to the stereo module. This unique tag would "ride along" with each TV channel so that the tag reaching the stereo module would be the one corresponding to the channel which the converter is tuned to. Either VBI or audio tone codes might be useful for tags since both can pass through most existing converters and are essentially invisible to the TV set. This concept of Figure 1 provides for hand-held remote control of channel selection to the extent that the converter supports same.

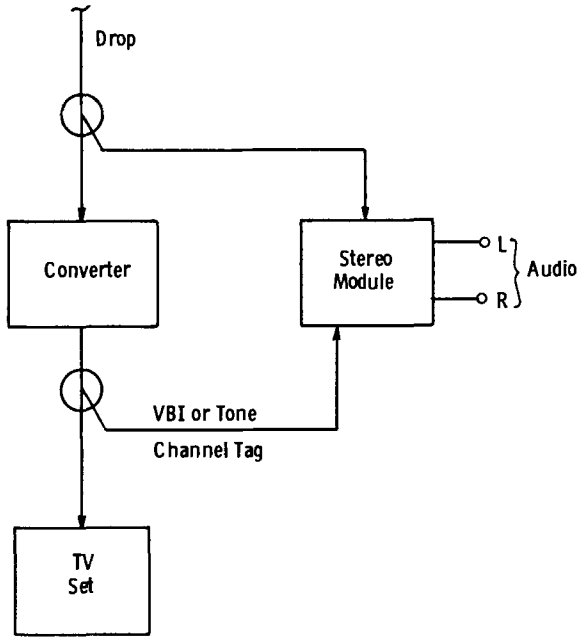

Figure 1. Stereo Module can be auto-tuned by VBI or tone 'tag' passed through converter.

In some cases, it might be necessary or desirable to not require a converter as part of the subscriber equipment. Figure 2 suggests a concept which satisfies that need. The suggested approach is to directly sense the channel that the TV is tuned to. This might be a sensor that gets installed in the TV set to detect some RF amplifier frequency. Another possibility might be for the sensor to 'listen' for some unique subaudible tone 'tag' that gets passed through the TV and is available at the speaker.

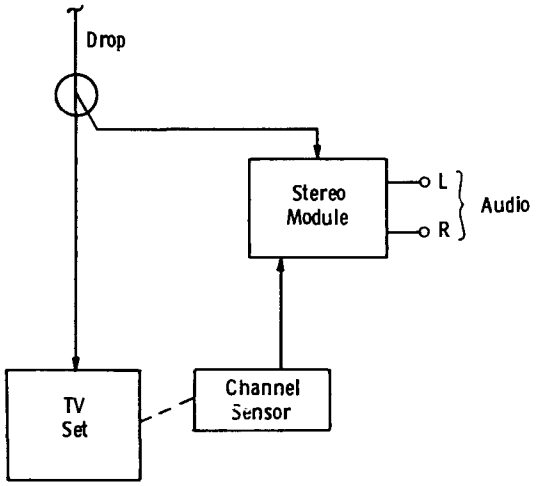

Figure 2. Stereo Module can be auto-tuned by sensing TV channel directly.

Figure 3 suggests an embodiment that is very attractive. This embodiment again does not require a converter (although does not preclude) and makes use of a hand-held remote control to tune the TV (if applicable) and also to tune the stereo module. The stereo module in Figure 3 includes an IR receiver so the hand-held remote control can communicate commands directly to it. This offers the option of remote-control volume, a feature heretofore associated with base-band converters. This approach would require some attention to dealing with the various IR remote control encoding formats now in use. It appears likely that a plug-in PROM in the stereo module might be one way of handling this variance. Another option might be to provide a special remote control that is universal.

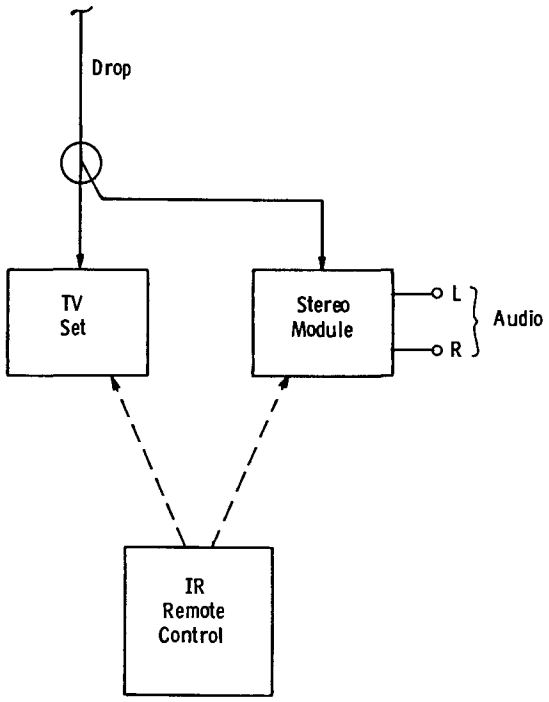

Figure 3. IR remote control tunes both TV and Stereo Module, and can offer remote-control volume.

SYSTEM IMPLICATIONS

As has been discussed, some new equipment would be required at the headend in addition to the above subscriber equipment. Operationally, it is important to understand how to go about specifying the new headend equipment. This issue has been approached by dividing headends into two categories according to the type of signal processing employed. The categories are (1) base-band types and (2) RF processing types.

Channels that employ RF processing could be modified in a number of ways. Referring to Figure 4, the solid line part of the diagram indicates the functional blocks in a single channel of RF processing headend equipment. Those functional blocks take incoming channel A and convert it to some IF frequency. Then the signal is reconverted from IF to the desired channel B for insertion onto the cable distribution system. The three

circled numbers in Figure 4 indicate locations where equipment could be introduced to remove the stereo sound, and replace it with monaural sound.

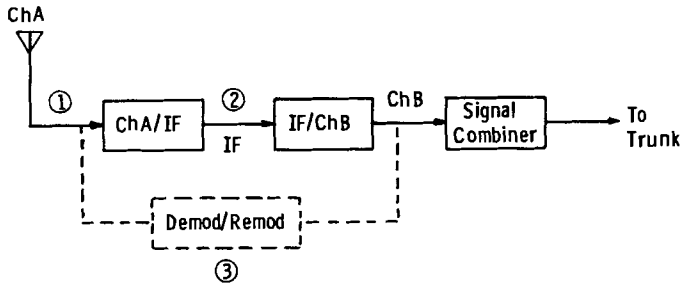

Figure 4. Alternatives for modifying RF headends.

Location 1 is where the antenna terminates at the headend equipment. A device could be defined for this location that detects and removes incoming stereo sound and replaces it with monaural sound. Such a device would deliver a conventional TV signal to the input of the headend equipment. The same device would make available L and R audio signals for delivery in the off-channel band. One potential disadvanage of this device is that it is channel-specific, probably requiring a different operating frequency for each off-air channel. The principle advantage of this approach is it is universal-- the necessary equipment will always be in the same location, is essentially independent of any other aspects of the headend, and requires no electrical/mechanical modifications to existing equipment. The correct equipment could be ordered by specifying nothing other than the channel frequency, and installation makes use of existing connectors and cables. For large MSOs, this could be a tremendous operational benefit.

Location 2 is the IF of the processor. The functional requirements of the device for location 2 is essentially the same as for location 1. The principle advantage is that most RF processors use a standard IF frequency, making it sort of a 'one-size-fits-all' device. The potential disadvantages are that the existing processor would have to be modified electronically and mechanically to break into the IF strip. In addition, ordering the required device seems to inherently require more in-depth understanding of the headend electronics.

Location 3 suggests replacing the RF processor with a demod/remod signal processor that has the functional attributes of detecting and removing the stereo signal, and replacing it with a monaural sound. While this approach is certainly feasible in a technical context, considerations of cost and available rack space might be a significant drawback.

The other category of headend equipment is base-band signal processors. Channels that use base-band headend signal processing are expected to remove the stereo from the incoming signal without any equipment changes. Presumably, these base-band devices will pass on to the subscriber some acceptable quality, non-stereo signal. But existing base-band signal processors would certainly require some modification to detect and make available the L and R audio channels. It may further be found that additional modification would be needed to replace the stereo with a higher quality mono sound for distribution over the cable. Alternatively, it should be clear that another option for base-band processed channels is the device described above for use where the antenna terminates at the headend input, further demonstrating the universal nature of that approach.

Regardless of the approach taken to remove stereo and replace it with mono sound, the final step is to take the detected L and R stereo components and modulate an FM carrier for distribution in some off-channel frequency band. The FM carrier frequencies could be in the FM-broadcast band, suggesting an FM receiver as reception equipment. Alternatively, the cable operator might dedicate some unused 6-mHz band to carriage of the FM-stereo signals, with the accompanying subscriber enhancements described above. In addition, some of the subscriber equipment options

described above require 'tagging' the TV channel to provide the auto-tune feature. These headend equipments are schematically indicated in Figure 5.

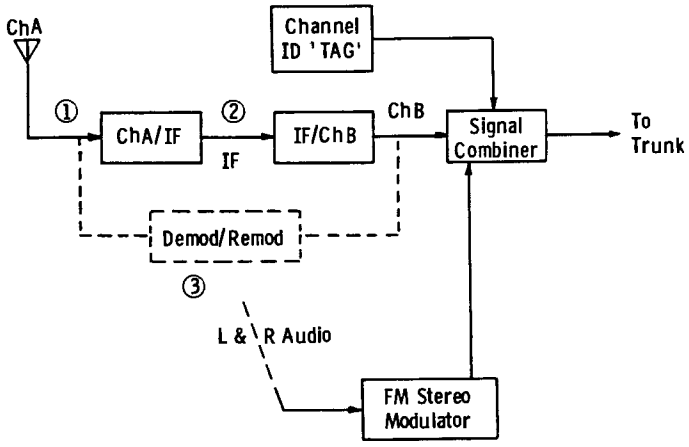

Figure 5. Full complement of equipment for modified headend.

ENHANCEMENTS

We have so far focussed on the essential equipment needed for delivering stereo to subscribers without requiring a new TV set and without requiring modification to existing set-top terminals. It should be noted that some additional features could be added to further enhance this approach.

One enhancement is that this approach plays into delivering bilingual programming. One language could be delivered over the normal TV signal, and the other language could be provided over the "stereo" band. This enhancement does not add cost to the subscriber equipment.

Another possibility would be to include in the "stereo module" some audio power amplification, permitting the module to drive stereo speakers directly. It is likely that this feature could be added to the subscriber equipment with very little additional cost.

The proposed equipment could be configured to also support some forms of 'enhanced' sound, using increased FM deviation, or might even be made to deliver digital audio.

By adding some additional circuitry to the "stereo module", it would be possible for subscribers to derive all audio, both stereo and mono sound, through the stereo speakers. This would provide 'improved' sound on all TV channels.

Finally, the utility of the hand-held remote control could possibly be expanded beyond the functions of auto-tuning and remote volume control. Other subscriber conveniences could probably be added to further enhance this equipment scenario. These possibilities are left to the imagination of the reader.

CONCLUSIONS

It is concluded that cable delivery of stereo sound TV in the same format as received off-air is not in the best interest of the subscriber, both from the standpoint of quality of delivered audio and video, and from the standpoint of subscriber equipment cost. Instead, this paper proposes and explores the equipment needed to deliver stereo-sound TV over cable in a way compatible with subscribers' home stereo equipment. It is concluded that the proposed approach is advantageous for both the customer and the cable operator. The customer would not need to purchase a "stereo" TV to take advantage of stereo broadcasts, and could be offered extra features such as remote volume control. The cable operator would not face the prospect of a massive change-out of set-top terminals. It is also concluded that nothing new needs to be invented to produce the necessary equipment and that the cost of that equipment compares very favorably with other alternatives.