Thoughts on Digital Audio Data Reduction

Few subjects of recent note have inspired as much emotion within the broadcast and audio industries as Digital Audio Data Reduction. It seems that finally, after years of relying on such harsh and final qualifications of audio systems as real-world measurements, the audio engineer is now forced to introduce his opinion of audio quality into the analysis equation. To the audiophile this is indeed a windfall, since the subjectivity of bit rate reduction systems offers endless opportunities to critique audio quality. And since no hard scientific analysis can be offered as to which system sounds transparent, any self appointed expert may criticize at will.

To the broadcaster, these systems are a mixed blessing at best. The only sane reason to install a system into your airchain which actually adds noise is, of course, for cost benefit. But that cost benefit is real, and often quite substantial. The ability to complete a difficult STL hop, or to store gigabytes of digital audio within megabytes of media, or to connect with any other point worldwide at near compact disc quality via a phone line are some fairly justifiable reasons do just that.

While most people involved in the implementation of reduction systems will agree that most do perform quite well, too much of a good thing will invariably lead to a bad thing. Broadcasters are finding how easy it is to find several systems "stacked" within their airchain. This has thrust a new word into the broadcast vernacular—transcoding. Transcoding is multiple generations of bit rate reduction on a single signal before broadcast. Depending on what types of reduction are used, and how much data they actually reduce, the audio quality at the end of the link may suffer to varying degrees. There are several factors involved in this degradation.

The first has nothing to do with the actual reduction algorithm. As more and more broadcast devices become digital in nature, more conversions between the analog and digital domain are required. Each time a signal is passed through an analog-to-digital conversion and a digital-to-analog conversion, noise is produced in the quantization process. This noise adds from device to device and eventually will be high enough in amplitude to affect your signal. Of course, this effect would be present in transfers from CD to DAT to any other linear digital device.

Much discussion has taken place on interface standards to avoid this problem. If the signal can be transferred in the digital domain from device to device, quantization noise may be reduced. In the broadcast airchain, enough devices remain analog in nature that some conversions are inevitable, e.g. most mixing consoles remain analog. However. the number of quantizations may be reduced by standards such as AES/EBU so that conversions have less effect on the signal than other factors.

The true transcoding artifacts are another matter. No matter how your audio arrived at your data reduction system, the system itself is changing your signal quite a bit. In the case of perceptual coding based algorithms, like the ISO/MPEG family, noise is actually being added to your signal, and parts of this signal

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which are deemed inaudible are left out. ADPCM systems, like APT-X, add less noise but some slight artifacts remain. As stated, most agree that a single pass through a data reduction system achieves good results. As a signal is passed through multiple codings, however, the previously inaudible artifacts and noise begin to rise and become noticeable.

It has been proposed that a single standardized compression algorithm would solve the problem. Indeed it would seem that if you add noise to a signal in a certain pattern once, multiple codings would add the same noise in the same pattern, producing the same output. However even a single algorithm, especially at high reduction rates, can achieve degradation with multiple codings. Also some algorithms offer these high reduction capabilities and some do not. Some exhibit superior quality, some are non-complex (and therefore lower cost) to implement, and some offer low processing delays. For this reason it would be extremely difficult to appoint one coding system as "the standard" and banish all the others.

Possibly the highest data reduction is required in the area where Comrex specializes. With the advent of ISDN, broadcasters are finding new opportunities for out-of-studio broadcasts with true studio quality. ISDN (or switched 56) is supplied in increments of 64 or 56 KB/s. A basic rate ISDN installation includes two, independent data channels at this rate which can be multiplexed together rather easily to provide 112 or 128 KB/s. Unfortunately, to get a broadcast quality stereo signal over this data rate requires a reduction approaching 10:1. To sum multiple basic rate ISDNs together gets much more complex and expensive. The highly reduced stereo digital audio signal (using ISO/MPEG Layer II, for example) does sound quite good and can become a very useful tool for some applications. The cost benefit associated with this system is enormous, given the alternatives of equalized telephone lines or satellite links.

But if the bottom line becomes the prime concern, this type of system begins to look appealing for STL and other "backbone" operations. A digital audio signal with 10:1 reduction is a prime candidate for transcoding problems, and this is where the "dueling algorithm" effect is of greatest concern in the short term. It should be noted that many STL systems currently employ a more "benign" data reduction of 4:1 with successful results.

We believe it is the manufacturer's responsibility to make his customer aware of the pitfalls of multiple data reductions in his airchain. Potential customers should be warned, and sometimes even discouraged, from implementing these systems if the application could lead to multiple reduction passes. Distributors of digital audio programming should inform all affiliates of whether data reduction has been used on their programs, and how much and what type. In some circumstances, we intend to encourage our customers to "foot the bill" for larger transmission and storage media in their airchain. We believe education is the best tool and should be applied where it belongs, in advance of the sale and installation of such a system.

We also believe that data reduction products, including ours, offer a significant benefit to the broadcaster and are here to stay. We encourage our competitors to form an alliance with their customers in choosing appropriate systems for their applications, and we applaud those in the industry who have brought these concerns forth. It is Comrex's intention to offer a variety of data reduction systems, each suited to particular applications and needs. It is also our intention to inform our customers and potential customers of both the good and bad qualities of such systems.

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