

## TRENDS IN HIGH RESOLUTION AUDIO – JANUARY, 2015

Growth in high resolution audio (HRA) over the last several years has been robust. HRA is an established mainstay in the professional and audiophile markets. However the arrival of new formats and refinement of the associated processing, along with the growth of internet delivery, and now a significant industry effort to make HRA a mainstream format, all herald an interesting and promising next few years. The HRA Technical Committee sponsors workshops, tutorials, and discussions highlighting significant aspects of these developments for the AES community.

### NEW HRA FORMATS

Especially notable in the last two years has been the rapid emergence and uptake of DSD as an independent encode and distribution format. DSD is the term used by Sony and Philips for the single bit stream output of a sigma delta converter that, together with related processing, is used in storage and transmission associated with the production of SACDs. The original DSD oversampling rate of 64 Fs (64 x 44.1 kHz, or 2.8224 MHz) has now been expanded to include both 128 Fs and 256 Fs. The main advantage of the higher rates is that the rise in shaped noise which occurs as a consequence of dynamic range processing in sigma delta modulators can be pushed considerably further out beyond the audio band (> 60 kHz), and with less quantization noise remaining in the audio band, than is possible with 64 Fs. The DSD signal is said to sound cleaner and more transparent at the higher data rates.

Also related to DSD is DXD, a designation for PCM at 352.8 kHz/24b championed by Merging Technologies as an intermediate stage in DSD processing. Single bit streams cannot easily be filtered or processed and so are typically converted to PCM at high sample rates to facilitate production. More than just an intermediate stage, DXD's uses are evolving with some recording engineers employing it as a direct recording format for release in DSD, as an intermediate between DSD record and release, and possibly in the future as a 352.8 kHz PCM release format.

This trend to higher sampling rates in both PCM and DSD is supported by consumer and professional hardware. Many current DACs and ADCs support both PCM and DSD. New converters, software, and even portables increasingly support PCM from redbook (44.1kHz/16b) up to 384 kHz/32b and DSD to 256 Fs as the industry continues to explore both the merits and the degree of consumer interest in these formats. An open standard for packing DSD into PCM frames known as DoP has been adopted by major manufacturers to facilitate transfer of DSD across USB interfaces as well as AES and SPDIF.

### IMPROVED CONVERTERS, FILTERS, AND SIGNAL PROCESSING

While high quality audio has always sought to define the sources of sonic deterioration associated with processing and filtering music data, high resolution and now higher resolutions are both the outcome of, and drivers of, this search. There is at present an effort by manufacturers of high quality converters to address shortcomings attributed to the upsampling chips and multi-bit sigma delta modulator chips used nearly universally in PCM DAC processing. Techniques include substitution of FPGA or computer-based upsampling for that found on chips, custom filter design including minimum phase designs, increase of processing bit depth to double precision floating point (64b) or above, and custom sigma delta modulation and decimation. Several chip makers however have developed improved chips incorporating similar processing upgrades, plus improved noise shaping, jitter control, clocking and isolation. Such chips are increasingly appearing in new HRA-capable hardware.

The theoretical and practical influence of filters on sound has long been debated, and a new test program initiated by Meridian Audio seeks to explore some of the audibility questions. In an important first paper given at the AES 137<sup>th</sup> convention, Meridian authors H.M. Jackson *et.al.* measured the audibility in double blind tests of downsampling filters typical of those used in CD preparation when such filters were applied to a higher resolution stream without decimation and played through a high quality audio system. Their result disputes that from an earlier paper by E.B. Meyer and D.R. Moran (J.A.E.S. 55: 775-779, 2007) and provides evidence and a likely mechanism for an audible distinction between CD and higher resolutions.

## DISTRIBUTION, STORAGE AND REPLAY

Distribution of HRA files is now primarily internet-based. Download websites ranging from large aggregations down to small labels and orchestras now exist and offer both new work and remastered back catalog. PCM resolutions ranging from 192 kHz/24b to 44.1 kHz/16b are available, and DSD at 64 Fs and 128 Fs is increasingly available. PCM above 192 kHz and DSD at 256 Fs are not yet significant factors but DAC manufacturers are including support for them anyway due to the rapid upward trend in bandwidths. FLAC, WAV and AIFF are the dominant PCM transmission formats. Streaming is likely to supplement or replace downloading in the future as it is doing now with compressed music and lower resolution video. Although streaming bandwidths currently limit music resolution to losslessly compressed CD, a new codec designated MQA was recently introduced by Meridian Audio that is said to losslessly encode higher resolutions at bit rates slightly below those of CD. If successful, MQA may greatly influence the streaming of high res audio.

The emphasis on downloads correlates with the continuing strong trend toward adoption of computers, file servers and portables into all areas of music including the traditional two channel audiophile music marketplace. Blu-ray movies incorporating HD audio also continue to sell well despite the continued decline of physical media, and there is a small dedicated market in high quality audio-only Blu-rays.

## NEW MARKETS

Notable are two new initiatives to bring high resolution audio into the mainstream mass market. Behind these efforts are several factors: first, the considerable business success of the larger HRA download websites in the audiophile market, and then, a broader quest for higher quality as a result of the many complaints about the ubiquity of compressed low bit rate audio. Pono, an HRA music download service coupled with a well-engineered portable music player, is the product of multiple years of effort by the artist Neil Young. Pono is set to begin sales in late 2014. The second is a significant combined initiative from the Digital Entertainment Group (DEG), Consumer Electronics Association (CEA), the Recording Academy, and the major labels. They have developed an HRA definition and a set of provenance designators for future releases, and are currently sponsoring talks and demonstrations of HRA at trade events, including the AES 2014 Los Angeles convention. Provenance has been a major source of consumer complaint in the past because many DVD-A, SACD, and downloaded files labeled high resolution were merely upsampled redbook. Thus the optional use of designators is an attempt to redress the issue.

Also of note are several initiatives to make multitrack audio available to the research and education communities. These include the Open Multitrack Testbed, MedleyDB, the Free Multitrack Download Library, and the Structural Segmentation Multitrack Dataset. Many of these include better than redbook quality tracks, stems, and mixes, and typically contain content available under Creative Commons licensing, allowing some degree of reuse or redistribution.