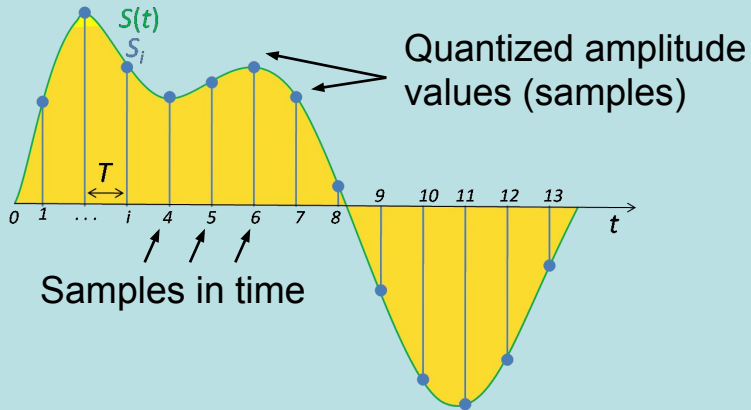


WHAT IS HD AUDIO?

What constitutes Hi-Res Audio?

- Microphone placement
- Recording equipment
- Post production methods (mix, mastering)
- Consumer release format
- Playback equipment (consumer level)

Digital Audio Signal



Digital Audio Signal – PCM

- PCM – Pulse Code Modulation
 - Digital encoding used on standard audio CD
 - 65K amplitude quantization levels (16 bits)
 - 44.1kHz sample frequency

Quest for better / higher resolution

- PCM as used on standard CD has 2 parameters:
 - Number of quantization levels (wordlength, 16 bits)
 - Sample frequency (44.1kHz)
- Increase either parameter or both for higher resolution

Typical PCM Formats

- High Resolution
 - Word lengths: 24 bits, 32 bits
 - Sample frequencies: multiples of 44.1kHz or 48kHz up to 384kHz

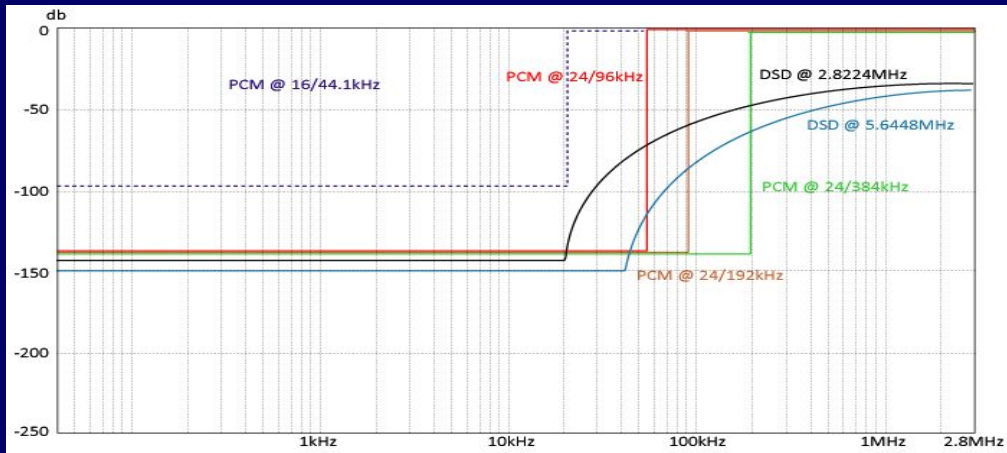
The problem with PCM

- “Digital Sound” caused by steep and unnatural filters used in conversion from analog to digital and digital to analog
- Higher word lengths and sample rates help, but still the same problem

Alternative to PCM

- Direct Stream Digital – DSD
 - Used on Super Audio Compact Disc (SACD) launched 20 years ago by Sony and Philips as high resolution audio carrier with better performance than PCM.
 - 1 bit quantization, sample frequencies between 2.8MHz and 11.2MHz

Spectrum DSD vs. PCM

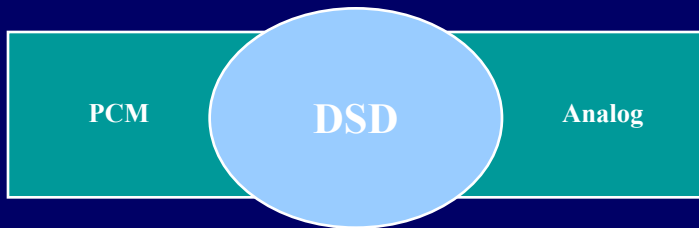


DSD Today

- Niche format, but widely accepted in audiophile market as superior format
- Characteristics are closer matched to our hearing system than PCM => no “digital sound”

The Format between PCM and Analog

- advantages of a digital signal (like PCM)
- characteristics of an analog signal



The download bottleneck

- File sizes for a 3 minute song and download times (assuming 10Mb/sec internet connection):

Redbook (16/44.1kHz)	32MB	0.5 min.
24/88.2kHz	95MB	1.3 min.
24/96kHz	103MB	1.4 min.
24/176.4kHz	190MB	2.5 min.
DXD (24/352.8kHz)	380MB	5 min.
DSD	127MB	1.7 min.

DSD is very bit efficient for high-res. downloads

Conversion between Formats

- In general any format conversion during production should be avoided as much as possible
- Conversion between PCM and DSD can harm sonic qualities of DSD signal
- Because DSD has similar sonic characteristics as analog, conversion between analog and DSD is acceptable.

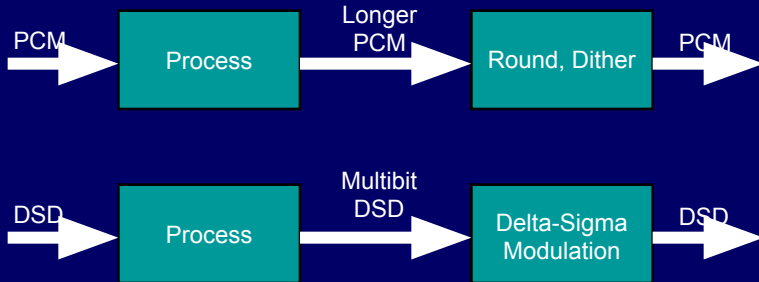
DSD Processing

- Classic PCM model



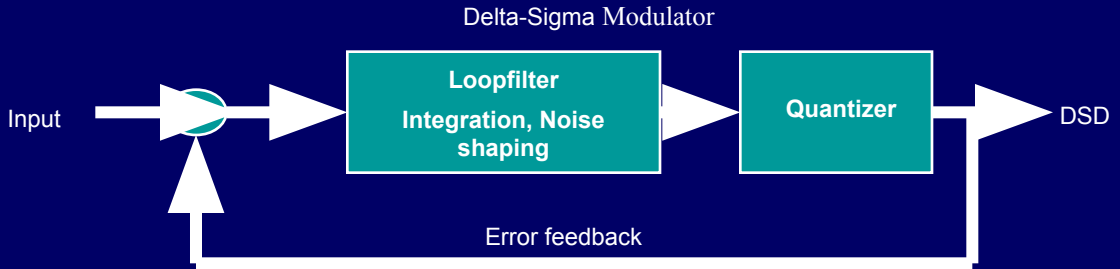
DSD Processing

Classic model



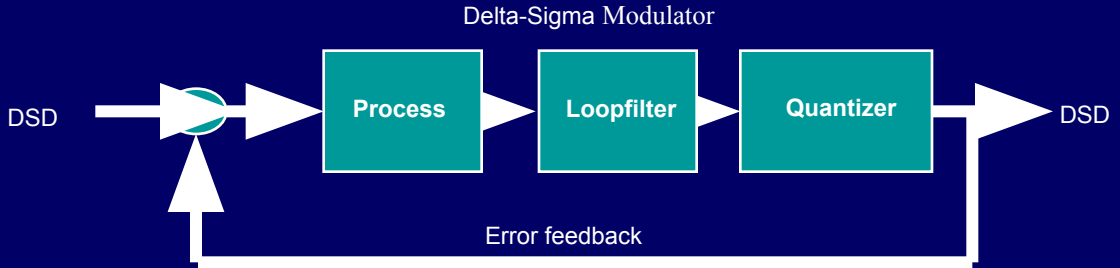
DSD Processing

- DSD model



DSD Processing

- DSD model



Conclusion

- Technology and production tools exist and are well supported for higher resolution audio
- Technology and digital audio format alone do not constitute high resolution performance
- True HD audio performance requires somewhat a step back in time when sonic performance was in higher demand than today and the recording studios had to deliver it.