



DTS Audio Restoration™: Compressed Audio Regains Punch and Clarity

White Paper

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Executive Summary

Audio recordings are frequently mastered, remastered and broadcast using technologies that sacrifice punch and clarity to compress the signal and maximize loudness. As a result, audio mixes often sound muddy and dull at moderate volume because the transients (such as drum hits) are unnaturally confined. DTS Audio Restoration performs adaptive dynamics enhancement to intelligently analyze audio and bring back the vibrancy of the original mix. When implemented in audio/video receivers, TVs, laptops, and other electronic devices, DTS Audio Restoration delivers the clarity and punch that listeners demand.

“Dynamics” Defined

In the context of this paper, “Dynamic Range” refers to peak-to-average level ratios.

“Transients” refer to level spikes that stand out from the surrounding content.

The Loudness War, Compression and Audio Quality

The so-called Loudness War has profoundly impacted audio recording sound quality (Masterson, 2008) (Curn, 2009). Driven by conflicting priorities, music companies push for high average loudness while sound engineers and recording artists seek ways to protect their audio artistry. So far, the louder-is-better approach has largely prevailed.

Metallica Fans Revolt Against High Loudness

Music listeners have become increasingly sensitive to remastered recordings with dull and distorted sound. Metallica’s “Death Magnetic” CD - perhaps the foremost example of aggressive loudness mastering - inspired a fan revolt. Fans demanded a less-loud remaster with more dynamics and less aggressive compression and limiting. (Kreps, 2008) (Michaels, 2008)

Broadcast recordings are now commonly mastered and remastered with high average loudness at the expense of punch and clarity. When used to maximize the average signal level, digital mastering techniques end up removing or limiting headroom and compressing transients.

As a result, recordings produced today typically have less dynamic range and are up to 20 dB louder than those produced 20 years ago (Smith, 2008). When listening to old and new tracks played back-to-back at the same loudness levels (after normalization), the difference is undeniable.

Since there is a maximum loudness level available for any recording, boosting it eventually creates a piece that is maximally and uniformly loud from beginning to end. If there are no quiet sections, there can be no contrasting loud sections.

The limited dynamic range of modern recordings can be fatiguing to listeners and devoid of the artist’s creative expression. Extreme use of dynamic range compression can even introduce audible

distortion to the waveform of the recording. For instance, listeners may notice that the harmonics created by clipping cause drums to sound muted.

The figures below illustrate the problems associated with aggressive remastering to achieve maximum loudness, followed by the common listener response to chronically high loudness levels (i.e., turning down the volume).

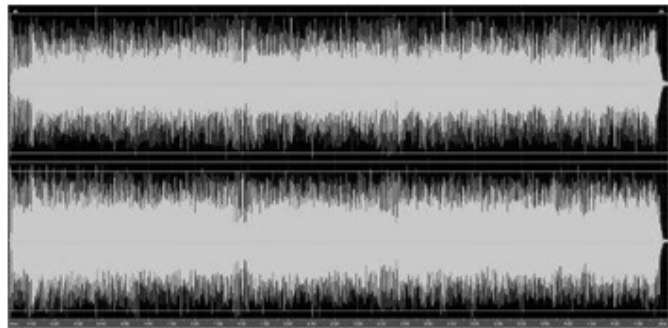


Figure 1: The waveform of the original recorded track, with transients clearly present

Figure 2 shows the results of aggressively remastering the original track shown in Figure 1. Transients are not retained, resulting in the loss of the audio signal's peaks and valleys apparent in Figure 1.

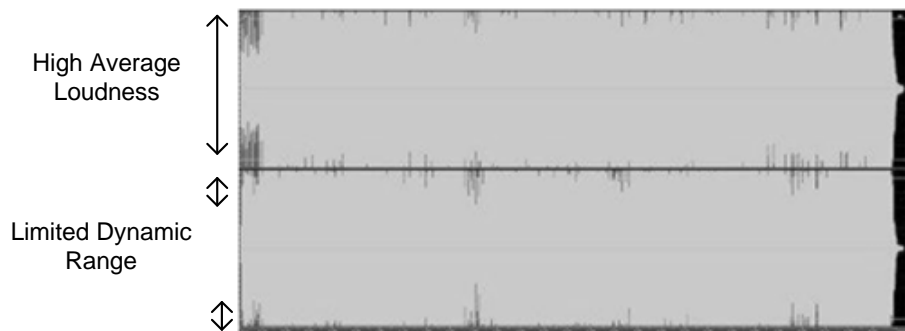


Figure 2: New version of the original track, remastered to maximize overall loudness

Many listeners find that remastered tracks (e.g., Figure 2) sound too loud, forcing them to turn down the volume to achieve the same level of loudness in Figure 1. At this stage, however, transients are no longer present in the original signal, resulting in a listening experience that is substantially diminished. This effect is illustrated in Figure 3.

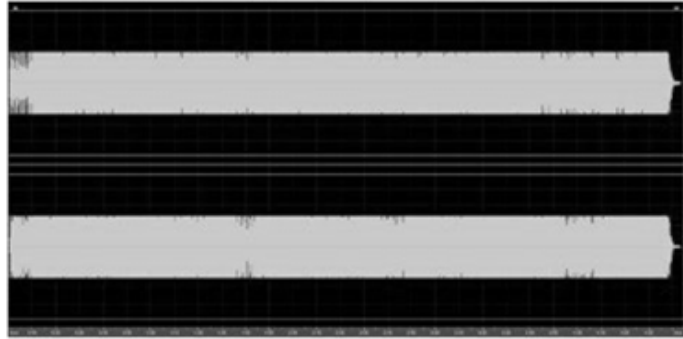


Figure 3: Loudness normalized to correct the listening level after transients were eliminated through remastering for maximum loudness

The DTS Audio Restoration Solution

DTS Audio Restoration offers the ability to enhance dynamics in music, movie or gaming soundtracks. This enables users of the algorithm to bring aggressively compressed music back to life, vastly improving the listening experience.

DTS Audio Restoration offers the following key features:

- Brings back the punch and clarity lost during audio compression and loudness enhancement introduced during mastering, remastering and broadcasting
- Intelligent analysis of short-term and long-term dynamics to enhance audio content
- Corrects the audio signal in frequency bands only where detected transients exhibit signs of dynamic range compression
- Avoids modifying the original signal when it is sufficiently dynamic

Compensation that Fits Your Musical Preference

In rock and pop recordings, transients are often dynamically compressed at the source and will benefit from enhancement by DTS Audio Restoration. Other types of music with sufficient dynamics or no transient content at all may not need to be enhanced. The algorithm automatically recognizes this. For listeners who want an even sharper, punchier sound or a more subtle effect than provided by the default setting, DTS Audio Restoration enables the additive dynamics processing to be adjusted.

Classical and ambient music is typically not hyper-compressed during mastering. As a result, it usually has sufficient dynamic range or negligible transients. Therefore, DTS Audio Restoration simply estimates the likelihood of any transient content and only enhances when appropriate.

To determine what compensation, if any, is appropriate, DTS Audio Restoration calculates a running estimate of the dynamic range. It then compensates for transients that show evidence of deleterious mastering practices. Again, the dynamic range refers to the level of signal peaks relative to the signal average, in this context. To keep the measured dynamic range at a value that fits the style or genre of the audio material, the algorithm provides adaptive enhancement.

Figure 4 illustrates how DTS Audio Restoration enhances transients (e.g. peaks), restoring the clarity and crispness of the original track. For the listener, the effect is especially compelling when compressed audio is played on a high-end stereo system using speakers and amplifiers designed for high dynamic range.

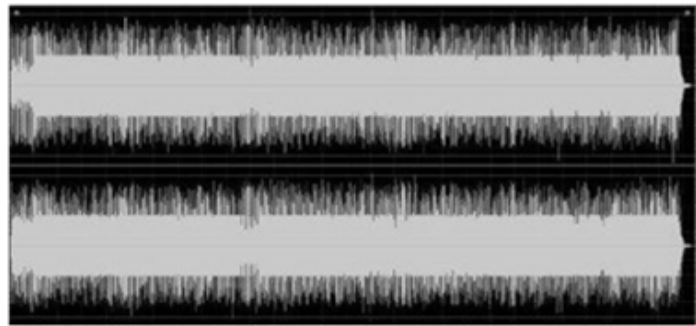


Figure 4: Result after DTS Audio Restoration is applied to overly compressed audio, enabling it to regain punch and clarity

How it Works

DTS Audio Restoration achieves the aforementioned objectives through the following process:

- Longer-term (overall) dynamics are measured
- Short-term dynamics are measured and analyzed to identify transients or tonal components
- If long-term dynamics do not meet the adjustable target value, a dynamic EQ is applied where transients were identified. This increases both the overall transient-to-average signal energy ratio and the dynamic range.
- Works in the frequency domain to handle complex source material (mix of transients and tonal sounds)
- Does not change material that a) achieves the target dynamic range (e.g., classic rock), or b) does not contain any transients (e.g., classical/ambient music)



Conclusion

Techniques used to master, remaster and broadcast audio recordings typically compress the signal, reduce dynamics and maximize loudness — all of which can distort an artist’s work and degrade the listening experience. Even if more conservative mastering techniques are adopted, this will not address existing recordings that have already been mastered and distributed to listeners.

To bring back the vibrancy of original recordings, DTS Audio Restoration intelligently analyzes audio and applies adaptive dynamic enhancement where needed. When implemented in audio/video receivers, TVs, laptops, and other electronic devices, DTS Audio Restoration brings recordings back to life, delivering the clarity and punch that listeners demand.

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