'Coherence': Explanations of what it is and its application as a plug-in

In simple terms, coherence in audio is like making sure different sounds play nicely together and do not interfere with each other. Imagine you're in a band, and each member is playing an instrument. Coherence is about ensuring that all the instruments are playing in sync, in tune, and do not interfere with each other, so that the music sounds great.

Think of coherence as teamwork for sounds. When sounds are coherent, they work together smoothly, like a well-practiced band. Here are a couple of everyday examples to help you understand:

1 **Echo in a Canyon:** Imagine you're shouting across a canyon and you hear an echo coming back. If the timing between your shout and the echo is just right, it sounds like one big sound. That's coherence! But if the echo comes back at odd times, it can sound jumbled and messy.

2 **Clapping in a Big Room:** Picture yourself clapping your hands in a large hall. If the sound waves from your claps bounce off the walls and come back in sync, the claps will sound strong and clear. However, if the echoes bounce around chaotically, the reflected claps might sound muddled.

3 **Singing in a Choir:** In a choir, everyone needs to start and stop singing together and be on pitch. If one person starts too early or too late, or is not in tune, the harmonies won't be as beautiful. Coherence in this case means the singers are all singing in time, on pitch, and creating a harmonious sound.

4 **Waves at the Beach:** When ocean waves come to the shore and merge smoothly, they create a calming and relaxing sound. But if the waves come from different directions and clash, it can create a chaotic and less pleasant sound.

5 **Traffic Signals:** Think of coherence like traffic lights working in harmony. When they're timed just right, cars move smoothly through intersections without crashing. But if the lights are out of sync, traffic can get messy and frustrating.

In audio, a track with good coherence means that different sounds work together harmoniously, just like a well-coordinated team or a synchronized performance. It's about making sure that the frequencies, timing and phases of different sounds match up properly, so they enhance each other and create a pleasing and clear listening experience.

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From an audio engineer's perspective, coherence refers to the degree of similarity or correlation between two or more audio signals in terms of their phase, timing, and amplitude relationships. It is a measure of how well the waveforms of different signals align and interact with each other. Coherence plays a crucial role in shaping the overall sound quality, spatial perception, and clarity of audio recordings and mixes. Here's a more detailed explanation of coherence in the context of audio engineering:

1 **Phase Alignment:** Coherence involves assessing how well the phase angles of different audio signals match up. When two or more signals are coherent, their peaks and troughs align, resulting in constructive interference and reinforcing certain frequencies. Proper phase alignment ensures that the combined signals add up in a desirable way, enhancing the overall sonic impact.

2 **Interference and Comb Filtering:** In cases where audio signals are not coherent, phase discrepancies can lead to interference patterns and comb filtering, which can result in audible distortion. Comb filtering occurs when signals with differing phase relationships mix together, causing some frequencies to cancel out and others to reinforce, resulting in an uneven frequency response and altered sound quality.

3 **Spatial Perception:** Coherence influences how we perceive the spatial characteristics of sound. When signals are coherent, they contribute to a stable and accurate stereo or surround sound image. This is crucial for maintaining a clear sense of directionality and localization of sound sources within the audio mix. When sounds are not coherent, the image can be perceived as unstable, possibly moving around dependent on the amplitude and frequency content of the music.

4 **Microphone Placement and Phase Issues:** Coherence is particularly important in multi-microphone recording setups. Poor microphone

placement can lead to phase issues, where different microphones capture the same sound source with varying amplitude and phase relationships. Ensuring coherence between microphones helps avoid phase cancellations and ensures a coherent and balanced sound, but is often difficult to accomplish.

5 **Sound Reinforcement and Room Acoustics:** In live sound reinforcement and acoustically challenging environments, coherence affects how audio waves interact with the room. Proper coherence between speakers and microphones helps minimize unwanted reflections and resonances, leading to a more even frequency response and improved intelligibility.

6 **Time-Delay Effects:** Coherence also plays a role in time-based effects like reverberation and delay. Adjusting the coherence of wet and dry signals in these effects can impact the perceived depth and character of the sound, allowing engineers to create a sense of space that suits the artistic intent.

7 **Creative Manipulation:** Audio engineers can intentionally manipulate coherence to achieve specific creative effects. For example, by adjusting the coherence, altered phase relationships between elements in a mix can result in unique textures, widen the stereo image, or enhance certain sonic characteristics.

In summary, coherence in audio engineering involves the phase and timing relationships between audio signals and their impact on sound quality, spatial perception, and creative possibilities. Engineers strive to maintain or manipulate coherence to achieve optimal phase alignment, minimize interference, and create captivating and immersive audio experiences.

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In audio engineering, coherence refers to the degree of similarity or correlation between two or more audio signals, usually measured at different points in a system. It is a quantitative measure of how well the phase and timing relationships are preserved between the signals from input to output. Coherence is an important concept when analyzing the behavior of audio systems, especially in situations where signal synchronization and alignment are critical, such as in acoustics, sound reinforcement, recording, and playback. The coherence of the input signal

to a system with that of the system output provides an indication of how much the system in question alters the coherence of the input signal.

Coherence is typically calculated using the cross-correlation function between two signals. The cross-correlation measures the similarity between two signals as a function of a time lag. Here's how coherence is understood in engineering terms:

1 **Phase Alignment and Timing:** Coherence is concerned with the alignment of the phase and timing of different signals. When two signals are coherent, their waveforms are synchronized, meaning that corresponding peaks and troughs can occur at the same time, in both signals. This alignment ensures that the signals reinforce each other, resulting in a clear and accurate representation of the original sound.

2 **Frequency Components:** Coherence also applies to the correlation between frequency components of signals. When signals are coherent across different frequencies, it means that the phase relationships between these frequencies remain consistent. In the context of audio, this helps maintain the tonal balance, a stable image, and accurate representation of the sound across the entire frequency spectrum.

3 **Interference and Comb Filtering:** In cases where signals are not coherent, interference patterns and comb filtering effects can occur. Comb filtering happens when signals with slightly different time or phase relationships mix together, causing constructive and destructive interference at different frequencies. This can lead to a hollow or colored sound, reducing the clarity and accuracy of the audio.

4 **Measuring Coherence:** Coherence is quantified using a value between 0 and 1, where 1 indicates perfect coherence and 0 indicates no coherence. A coherence value of 1 means that the two signals are perfectly correlated in terms of both amplitude and phase. Lower coherence values indicate less correlation and more difference or interference between the signals.

5 **Applications:** Coherence analysis is commonly used in various audio engineering scenarios, including acoustic measurements, microphone array processing, audio system alignment, and analyzing

the behavior of sound waves in different environments. Engineers use coherence measurements to optimize speaker placement, microphone positioning, and to assess the quality of audio systems in different spaces.

In summary, coherence in audio engineering refers to the extent to which the phase and timing relationships between audio signals are preserved. It plays a crucial role in ensuring accurate and faithful representation of sound, and can be maintained by minimizing distortion byproducts of system components on the input signal, and as a result, optimizing the performance of audio systems in various contexts.

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An audio plugin designed to affect coherence can offer valuable benefits in various audio engineering and production scenarios. Such a plugin provides indirect control over the phase and timing relationships between audio signals, allowing engineers and producers to manipulate and enhance the way sounds interact with each other. Here's why an audio plugin for affecting coherence can be advantageous:

1 **Creative Sound Design:** A coherence-affecting plugin enables creative sound manipulation by allowing users to intentionally introduce phase variations between audio signals. This can lead to unique and experimental sound textures that might not be achievable using traditional processing techniques. It opens up new avenues for artistic expression and originality in music production.

2 **Spatial Imaging:** Adjusting the coherence of audio signals can significantly impact the spatial imaging of a mix. By controlling the coherence, and in the process altering the phase relationships between different tracks, you can create a sense of depth, width, and three-dimensionality in the mix. It is also possible, by increasing the coherence, to remove the embedded distortion, which will reveal the original spatial imaging cues present when the recording was made. This can be particularly useful for enhancing the stereo field and creating immersive soundscapes.

3 **Stereo Widening and Narrowing:** Plugins that affect coherence can be indirectly used to widen or narrow the stereo image of a mix. By manipulating the coherence relationships between left and right

channels, you can alter the phase relationships to expand the perceived stereo width or concentrate the sound towards the center. This is a common technique to enhance the perceived width of a mix or to emphasize mono compatibility.

4 **Sound Localization:** Precise control over coherence can aid in sound localization, allowing audio elements to be positioned more accurately within the stereo or surround sound field. Engineers can use coherence adjustments to fine-tune the perceived location of sound sources, improving the realism and accuracy of the spatial representation.

5 **Fixing Phase Issues:** In multi-microphone recording scenarios, such as drum miking or ensemble recording, phase issues can occur due to microphone placement. A coherence-affecting plugin can help mitigate these issues by allowing engineers to essentially adjust the phase relationships between the recorded tracks. This can lead to better phase alignment and a more cohesive sound.

6 **Minimizing Comb Filtering:** Comb filtering occurs when multiple audio signals interfere with each other due to phase discrepancies and unwanted distortion by-products of the recording or playback amplification process. A coherence-affecting plugin can help mitigate comb filtering effects by allowing users to essentially align or de-correlate signals as needed, resulting in a cleaner and more transparent mix.

7 **Enhancing Drum and Percussion Sounds:** Plugins affecting coherence can be especially useful for manipulating the phase relationships of individual drum and percussion tracks by reducing the multi-microphone induced interference distortion. This can lead to punchier and more focused drum sounds, improved transient response, and better separation between different drum elements.

8 **Customizing Reverbs and Delays:** Coherence manipulation can be applied to reverb and delay effects to create unique and evolving spatial textures. By altering the coherence of the wet signal, you can shape the decay characteristics and stereo spread of the reverberated or delayed sound.

In essence, an audio plugin designed to affect coherence provides audio professionals with a powerful tool for shaping the spatial, tonal, and textural characteristics of sound. It empowers users to achieve a level of control over phase relationships that was traditionally very challenging to achieve, opening up new creative possibilities and improving the overall quality and depth of audio productions.