

A3D 2.0TM

Technology Brief



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A3D Introduction

Aureal's A3D audio technology has taken the PC audio community by storm. Many call A3D the 3Dfx of audio, because A3D does for your ears what the best 3D graphics have done for your eyes: it puts you in the middle of a realistically rendered, interactive environment. A3D does this by immersing you with real-world sounds that come from all directions and move interactively in all three dimensions. The success of A3D is based on the fact that it is robust, NASA based technology, that it performs its magic via hardware acceleration to keep applications moving fast, and that it works incredibly well on just about any audio playback device: headphones, standard stereo speakers, or multi-speaker arrays.

The current generation of A3D was introduced in 1997. One year later, A3D has become the emerging new standard for PC audio. Support for A3D has been incorporated into top selling PC games and applications from developers such as Activision, LucasArts, Electronic Arts, and GT Interactive. Today, over 60 first tier developers are working on over 100 new A3D titles for release in 1998. At the same time, A3D enabled PC audio products are available from over 20 sound card and PC manufacturers, including Dell, Diamond, NEC and Turtle Beach.

A3D 2.0 Overview

Building on the breakthrough success of A3D, Aureal is introducing A3D 2.0 as the next generation of its positional 3D audio standard. Designed to take full advantage of Aureal's upcoming Vortex 2 chip, A3D 2.0 is fully backwards compatible with A3D while introducing the following advances:

- **Vortex 2 support: more 3D sources, higher sample rate, bigger HRTF filters**
- **Aureal Wavetracing™: real-time acoustic reflection, reverb and occlusion rendering**
- **A2D: host CPU based A3D emulation mode for non-accelerated PCs**
- **A3D API: all-in-one interface to support A2D, A3D, and A3D 2.0 rendering features**
- **Advanced resource management features**
- **A3D authentication protection**

More 3D sources

Current A3D systems can render 8 concurrent sound sources in 3D space at any given time. While sufficient for today's games, the next generation of 3D applications is pushing this number to 16 sources, as provided by Aureal's Vortex 2 chip for a richer listening experience. Additionally, Vortex 2 provides up to 64 3D reflection sources, used by Aureal's Wavetracing technology to render sound reflections off of walls and additional objects in the 3D environment.

Higher sample rate and bigger HRTFs

Current A3D systems render audio at 22kHz sample rate. Vortex 2 significantly improves 3D audio positioning accuracy and overall quality by raising the rendering rate to 48kHz. At the same time, the length of HRTF filters (Head Related Transfer Function: the set of audio filters that form the core of positional 3D audio processing) has been doubled to apply 3D processing to the full 48kHz frequency spectrum of a sound source. The result is a new standard of quality for positional 3D audio (before anyone else has come close to reaching the current standard set by A3D).

Aureal Wavetracing technology

Developed over many years in conjunction with clients such as NASA, Matsushita and Disney, this new technology is a key advancement for A3D 2.0. Aureal Wavetracing parses the 3D geometry description of a space to trace sound waves in real-time as they are reflected and occluded by passive acoustic objects in the 3D environment. This means that sounds cannot only be heard as emanating from a sound source in 3D space (as in A3D), but also as they reflect off of walls, leak through doors from the next room, get occluded as they disappear around a corner, or suddenly appear overhead as you step into the open from a room. Reflections are rendered as individually imaged early reflections and as reverb late field reflections. Acoustic space geometries and wall surface materials are specified via the new A3D 2.0 API. The result is another quantum leap in audio rendering realism similar to the one experienced by listeners when switching from stereo audio to current generation A3D rendering.

Figures 1-5 illustrate Aureal Wavetracing in action in different 3D space geometries:

- Figure 1: no geometry, only a listener and a sound source, resulting in standard A3D direct path rendering (red line)
- Figure 2: simple occlusion case: listener, sound source and a wall that occludes most of the direct path between the two (faint red line)
- Figure 3: simple reflection case: listener, sound source and 3 walls that reflect the sound (green lines)
- Figure 4: simple reflection/occlusion case: listener, sound source, 2 walls that reflect the sound (green lines), one wall that occludes most of the direct path (faint red line)
- Figure 5: more complex reflection/occlusion case: listener, sound source, direct path (red line), and 6 walls that are reflecting the sound (green lines), with one reflection being occluded

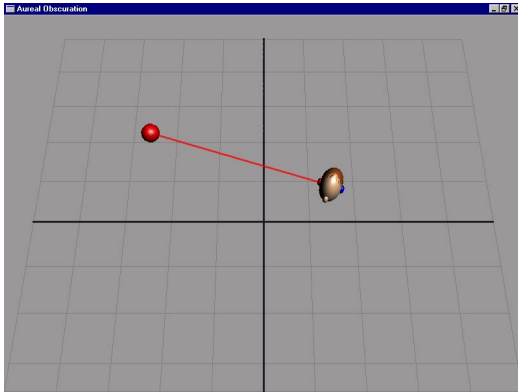


Fig 1. Direct Path

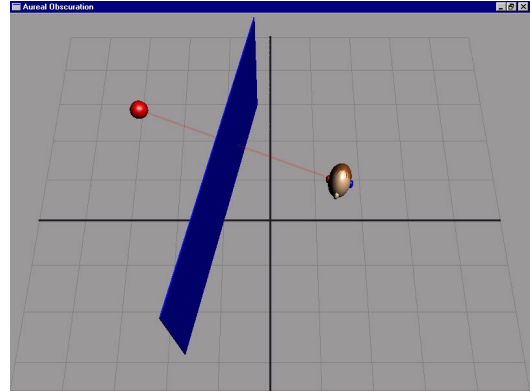


Fig 2. Occlusion

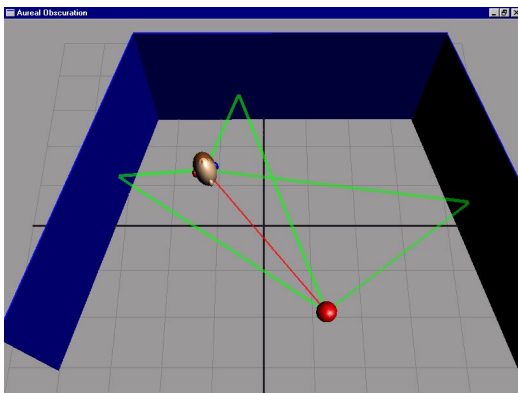


Fig 3. Reflections

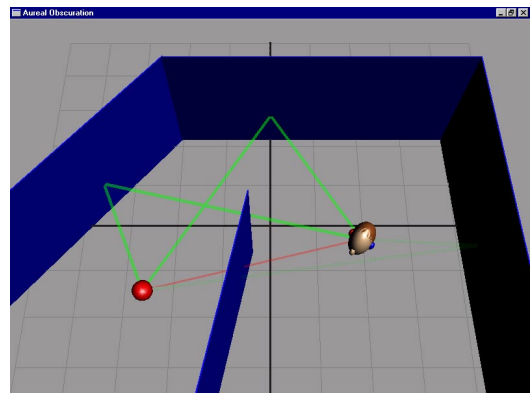


Fig 4. Occlusion and Reflections

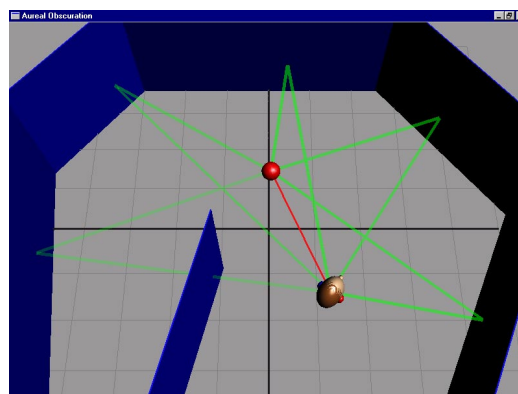


Fig 5. Occlusion and Reflections

A2D

Based on a heavily speed optimized, feature reduced version of A3D, A2D runs stand-alone on any host CPU to emulate A3D in a software only environment. As a result, A2D allows A3D 2.0 applications to run on any PC platform, even ones without A3D hardware support. A2D extends A3D 2.0 to offer developers a true all-in-one audio solution and a single API to code to.

Written in tightly optimized x86 assembly code, A2D significantly outperforms any other host based software fall-back solution with higher speed (lower CPU usage) and higher quality (better mixing, sample rate conversion and positioning algorithms):

	DirectSound	DirectSound3D	A2D	A3D	A3D 2.0
Default rendering rate	22kHz/8bit	22kHz/8bit	22kHz/16bit	22kHz/16bit	48kHz/16bit
CPU usage*	16%	68%	10%	<5% (runs h/w accelerated)	<5% (runs h/w accelerated)
32 Bit Mixing w/ Saturation	No	No	Yes	Yes	Yes
Sample rate conversion/ Doppler	Add/drop sample	Add/drop sample	2 nd order interpolation	4 th order interpolation	27 point interpolation
Distance Model	Gain	Gain	Gain	Atmospheric filter, gain	Atmospheric filter, gain
Positioning: Left/Right	Pan	Pan & delay (ITD)	Pan & delay (ITD)	HRTF	HRTF
Front/Back	-	Gain	Gain	HRTF	HRTF
Up/Down	-	-	-	HRTF	HRTF
Occlusions	-		Gain**	Gain, material filter**	Gain, material filter
Reflections	-	-	-	-	HRTF, reverb, material filters

* Intel's VTune utility measuring Pentium 166 with 8 sounds playing on DSshow software from Microsoft

**only when coupled with A3D 2.0 drivers

A3D API

The A3D 2.0 SDK features a greatly expanded A3D API (Application Programming Interface). It combines support for baseline audio playback and 3D positioning features with new resource management, 3D geometry and 3D scene management functions. Designed for simplicity, efficiency, and to mirror known paradigms from 3D graphics APIs, the A3D API represents the leading edge of interactive audio functionality. It also delivers 3D audio device independence without frame rate performance penalties: an application coded to the A3D API will run in A2D emulation mode on any Windows PC with any audio sub-system. A3D drivers will automatically that A3D or A3D 2.0 hardware will be engaged if available on the user's system.

In addition to the new A3D API, A3D 2.0 will continue to support existing A3D and DirectSound3D APIs for baseline 3D functionality.

Advanced resource management

Current A3D systems feature an intelligent resource manager that automatically maps complex acoustic spaces as defined by applications to the limited audio hardware resources available in a system. In other words, the application can play as many sounds as it wants without having to worry about what kind of audio sub-system it is playing on. The real-time resource manager efficiently picks out the most important sounds to play on available audio resources. A3D 2.0 further enhances this feature by adding new capabilities such as: support for looping sounds, sound source priorities, audibility culling, reflection management and room geometry culling.

A3D authentication protection

To ensure a consistent, high-quality playback experience for the user, A3D 2.0 applications will only run in full feature hardware accelerated mode on Aureal certified A3D systems (on all other systems, specifically systems that claim A3D compatibility but are not Aureal certified, applications will run in A2D host CPU mode). This is accomplished via a encrypted authentication procedure that verifies complete A3D 2.0 compatibility in a driver before hardware is engaged.

A3D 2.0 benefits to current A3D systems

While designed for Aureal's upcoming Vortex 2 PCI audio chip, A3D 2.0 drivers and applications will also enhance existing A3D solutions. Sound occlusions (via Aureal Wavetracing technology), advanced resource management and A3D authentication features will take advantage of existing hardware, while higher number of sources, higher sample rates, and reflections are only available on new Vortex 2 based systems.