



# Technical Brief

## UltraShadow II

### Accelerated Shadow Calculations



# UltraShadow II and GeForce GPUs

The NVIDIA® GeForce™ 6 and GeForce 7 Series of graphics processing units (GPUs) feature NVIDIA® UltraShadow™ II technology, which accelerates the computations for determining shadow interactions in an immersive environment. UltraShadow II lets developers introduce more complex lighting effects and enable high-quality, cinematic realism in next-generation games like *DOOM 3*™ from id Software (Figure 1).



Photo courtesy of id Software, © 2004.

Figure 1. Leading-edge game developers want to design complex digital light sources and realistic shadows, as illustrated in this scene.

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## Speeding Up Shadows

Accurate shadows are critical for realistic and believable scenes. The complex interactions between multiple light sources and numerous objects and characters involve multiple-pass programming. For every frame, every light source must be analyzed for each object.

By applying NVIDIA's patent-pending UltraShadow II technology to today's games, developers can build stunning visual effects to create distinctive looks and digital environments that set their games apart from the competition. This is a result of increased performance during the lighting and shadow pass phases of rendering. In fact, the new technology in UltraShadow II allows for a 4× performance increase (compared to the previous generation) for passes involving shadow volumes—without the developer having to do any work.

## Technology Advances

Stenciled shadow volumes do not require texturing or color updates. As a result, UltraShadow II hardware can *double* the rendering horsepower to generate stenciled shadow volumes at up to twice the standard pixel-processing rate. This benefit comes free to developers, is transparent, and requires no coding work on their part. GeForce 6 and GeForce 7 Series hardware magnifies the benefit of this new approach by accelerating the generation of shadow volumes up to four times the previous rate. This performance level can be increased even more if the developer is willing to put in a couple of additional calls to the UltraShadow II hardware.

Additionally, NVIDIA UltraShadow II lets programmers calculate shadows more quickly by eliminating unnecessary areas from consideration. With UltraShadow II, programmers can define a bounded portion of the scene (often called “depth bounds”), which limits the calculation of lighting source effects to objects within that specified area. By limiting calculations to the area most affected by a light source, the overall shadow generation process is highly accelerated. Figure 2 shows how to define a subset of a scene to limit lighting and shadow calculations to the appropriate area for each light source.

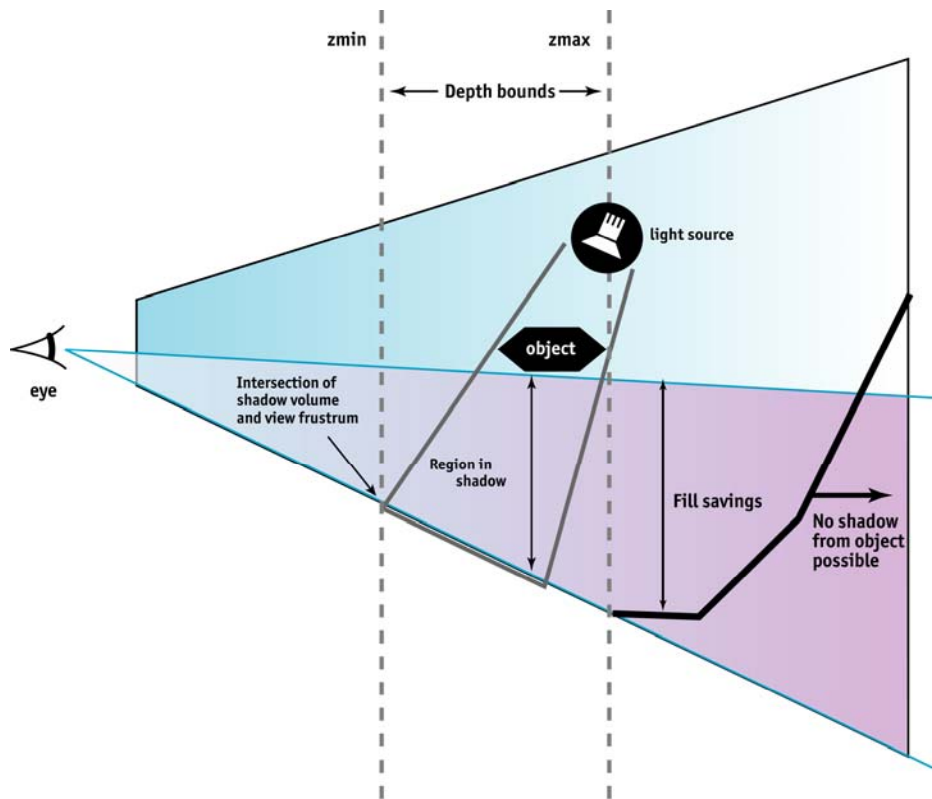


Figure 2. Setting  $z_{min}$  and  $z_{max}$  values to limit lighting/shadow calculations to the appropriate area for each light source.

Programmers can fine-tune shadows within critical regions, create incredible visualizations that mimic reality, and still achieve awesome performance for fast-action games. The accelerated shadow generation can also free up time for developers to allocate to other sophisticated, time-consuming effects.

In the following figures (Figures 3, 4, and 5), notice how using UltraShadow II substantially reduces the amount of shadow area that needs to be examined. UltraShadow II increases performance by actually *culling* shadow pixels—the hardware ignores shadow pixels that do not contribute to the final image.



Photo courtesy of id Software, © 2004.

Figure 3. A scene from *Doom 3*.

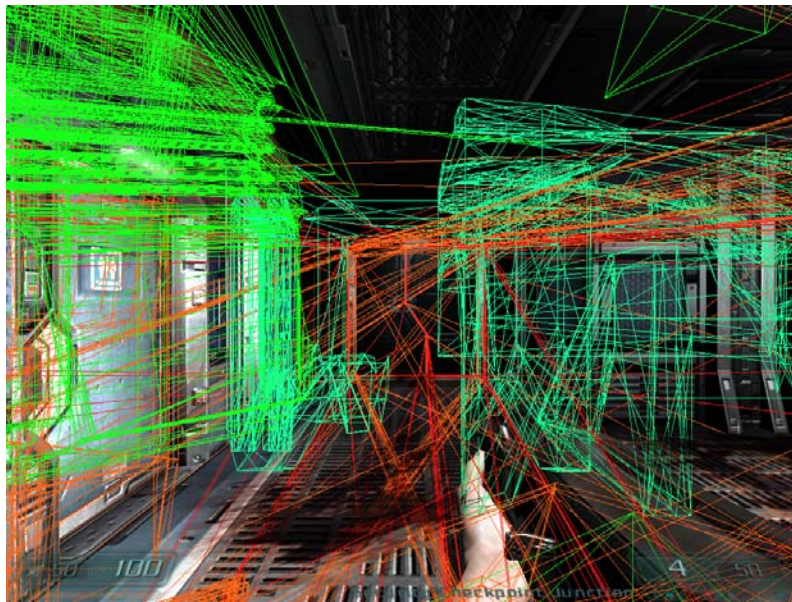


Photo courtesy of id Software, © 2004.

Figure 4. The lines are the extruded silhouettes that result from calculations done in shadow and lighting passes without UltraShadow II.

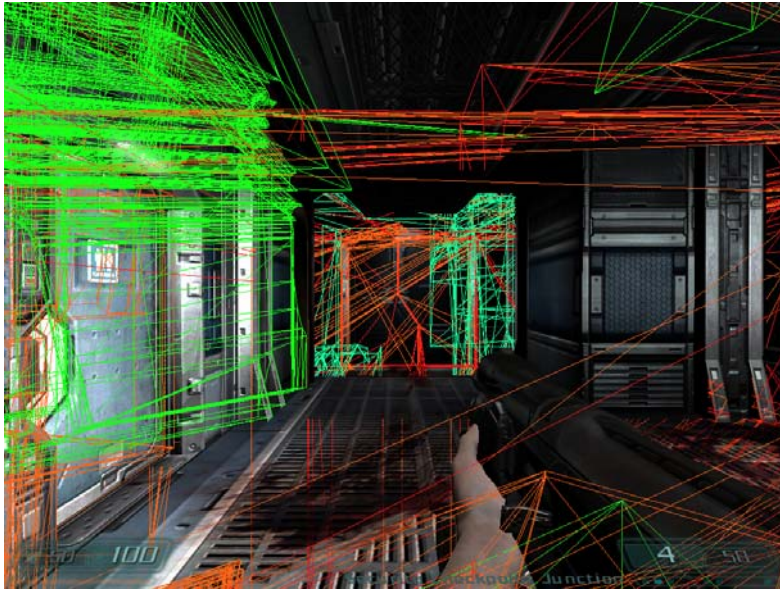


Photo courtesy of id software, © 2004.

Figure 5. The same image—with fewer extruded silhouettes—with UltraShadow II applied.

UltraShadow II also works perfectly with the NVIDIA® Intellisample™ technology to make sure that shadow edges are properly antialiased. NVIDIA GeForce 6 and GeForce 7 Series GPUs maintain stencil information on a subpixel basis, ensuring that shadow edges are antialiased to prevent a blocky or jaggy look.

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## Applications

The NVIDIA GeForce 6 and GeForce 7 Series of GPUs with UltraShadow II technology enables a new generation of gaming effects. Anytime a game or application calculates shadows, UltraShadow II will enhance the overall application performance. The more passes that are required for the lighting and shadow calculations—for example, in scenes that involve multiple light sources and many visible physical objects—the more significant the performance improvement, with the most complex scenes achieving the most noticeable results (Figure 6).

With the GeForce 6 and GeForce 7 Series and UltraShadow II, advanced games like *DOOM 3* can dramatically speed up their execution.



Photo courtesy of id Software, © 2004.

Figure 6. Advanced games use UltraShadow II to create photorealistic shadows, contributing to compelling digital experiences.

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## Summary

The NVIDIA GeForce 6 and GeForce 7 Series of GPUs represent a major leap forward in real-time cinematic effects. By delivering innovative technologies like UltraShadow II, the GeForce 6 and GeForce 7 Series power complex effects in today's leading-edge games.



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