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3DMARK05

Technical FAQ for 3DMark05 v1.1

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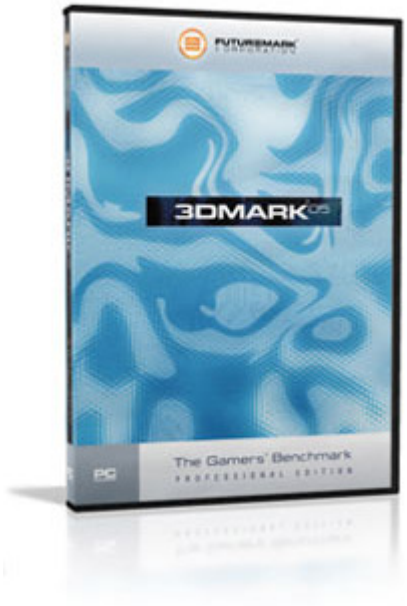

Patric Ojala & Nicklas Renqvist
Futuremark Corporation

Kappelitie 6 D
FIN-02200 Espoo
FINLAND

FUTUREMARK CORPORATION

Introduction

There have been a lot of technical questions regarding 3DMark05, both amongst the users and the media. In order to get the most frequently technical questions answered, we prepared this document, and will keep updating it as needed.

Version 1.0 of this document seems to have served its purpose, since the amount of requests for additional information about 3DMark05 decreased substantially with the release of this document. We have still got some feedback from the media and users, and a few further questions and requests from the Benchmark Development Program members to specify some details.

We have highlighted revised or new content with italics.

Q: Which 3DMark version should be used with what hardware?

A: The minimum system specifications for 3DMark05 are: DirectX 9 graphics hardware with shader model 2 support, a CPU with SSE support corresponding to 2 GHz or above, Windows 2000 or XP with the latest updates installed, DirectX 9.0c or later with the latest updates installed. If your system does not meet with these specifications, you should use 3DMark03 or 3DMark2001 instead. Just looking at graphics hardware, here are our recommendations on which 3DMark version to use:

- **3DMark05:** The latest and greatest hardware, second generation high-end or mid range DirectX 9 cards, first generation most high-end DirectX 9 cards.
- **3DMark03:** Second generation value to low-end DirectX 9 hardware, first generation mid-range to low end DirectX 9 hardware, high-end to mid-range DirectX 8 hardware.
- **3DMark2001 SE:** Mid-range to low end DirectX 8 hardware, all DirectX 7 hardware, (and any older hardware you manage to run on it)

Q: Is 3DMark05 all graphics bound like 3DMark03 was?

A: 3DMark05 scales more with the system performance than 3DMark03, due to the more game like engine. Still, a benchmark is basically always either graphics or system bound. 3DMark05 was designed to scale well with the graphics hardware on high-end systems at the time of launch, combining high-end graphics hardware, CPU and memory sub-system. This was to enable 3D performance benchmarking in future games, and no other benchmark is as dedicated to this goal as 3DMark. That was also the recommendation by the IHV members in the Futuremark Benchmark Development Program. Here are some result examples, showing how 3DMark05 performs when bottlenecked by either the CPU or the graphics hardware:

- Minimum requirement graphics hardware, minimum requirement CPU: 952 3DMarks
- High-end graphics hardware, minimum requirement CPU: 2664 3DMarks
- Minimum requirement graphics hardware, high-end CPU: 1008 3DMarks
- High-end graphics hardware, high-end CPU: 5108 3DMarks

3DMark is always scaled to give around 5000 3DMarks on a high-end system at the time of launch. A system built according to the minimum requirements give about 1000 3DMarks. Low-end graphics hardware chokes even a high-end system and keeps the 3DMark score down around 1000. A high-end graphics card, on the other hand, lifts the score of a low end system to 2664. However, that system cannot feed the graphics card any faster even though the graphics card could draw faster.

Q: I see some flickering in the shadows of the canyon walls of game test 3 / I see some odd looking blocky shadows in some game test / I see some shadow artefacts in some game test?

A: 3DMark05 uses a depth shadow map implementation in all game tests. All shadows are dynamically rendered everywhere in all game tests. This is quite an accomplishment, since indoor vs. outdoor areas have usually had very different dynamic shadow implementations, or then only partially dynamic or static pre-rendered shadows have been used. It seems clear that most big game developers are either going for depth shadow maps in upcoming titles, if not already using them in their latest titles. Depth shadow maps are suited for all environments and refinements in the rendering method produces high quality shadows both right in front of the camera as well as miles away. Depth shadow maps also do self shadowing and produce correct shadows from partly transparent surfaces (using alpha test, not alpha blend, to be exact). Still, there are certain light vs. surface angles that are challenging for depth shadow maps. 3DMark05 uses a 2048x2048 depth map twice for shadow rendering of directional light sources, like the sun in game test 3, but even that resolution isn't quite enough for the canyon wall. The canyon in game test 3 is actually a prime example of a worst case scene for depth shadow maps. We still wanted a fully dynamic lighting solution, so if the sun were waved around, the lighting including the shadows would remain correct. In some parts of the game tests, with most difficult light vs. surface normal angles, the shadows do get blocky, or show a flickering edge on all hardware. It is an implementation compromise, not a driver problem.

Q: Why are the CPU tests running so slow?

A: They run at an average frame rate of less than 5 fps on most systems. The CPU tests run the game tests at low resolution using software vertex shaders. No currently available CPU can handle over 1 million software vertex shaded vertices per frame faster than that. The measurements are still reliable and comparable.

Q: Why do I get a variation in CPU scores on some systems?

A: We have not been able to reproduce this here in our test lab, but we have got a few reports about this. It is true that a test with as low frame rates as the CPU test of 3DMark05 can give varying results. In addition to that, CPU test 1 contains real time AI calculations that tend to cause more variance in the results. Same type of behaviour often times happens with real time physics. The 3DMark05 CPU test still seems quite repeatable, except on the few systems we have got the reports on. We are working on this issue.

Q: Why do you use DST by default, even though that is an IHV specific feature?

1. DST (Depth Stencil Texture) is not an IHV specific feature any longer.
2. DST is a hardware accelerated feature for making depth shadow map implementations faster.
3. DST is the logical way to implement depth shadow maps. It's not just a numeric value that is read from some texture and then compared to another numeric value in a shader (like the non-DST path works). The DST values are specifically defined as depth values, and just reading the DST automatically performs the needed comparison.
4. Over a dozen of the biggest game developers use DST in their depth shadow map implementations of current and upcoming titles. Game developers using both OpenGL and the DirectX API use DST. Examples of games using DST: Far Cry (Crytek / Ubisoft), Splinter Cell (Ubisoft), Homeworld 2 (Sierra), Tomb Raider: Angel of Darkness (Eidos), Tiger Woods (EA). In addition to these, many of the most hyped upcoming games and engine technologies implement DST, but we can’t list these due to NDAs.
5. We don't have info of any major game using depth shadow maps that would NOT have a DST path.

6. Even though DST is not considered an official DirectX feature, the DirectX documentation (MSDN) includes a large number of references to DST and instructions on how to make an implementation.
7. DST is part of the standard rendering pipeline of the next major version of DirectX. This means that all major graphics IHVs will most likely support DST in the near future.

In summary, it is on by default, because this way 3DMark05 score correlates better with real-world gaming performance for hardware that supports DST.

Q: Why do you use hardware PCF by default, even though that is an IHV specific feature?

1. Hardware PCF (hardware accelerated Percentage Closest Filtering) is not an IHV specific feature any longer.
2. Hardware PCF is a hardware accelerated feature for making depth shadow map implementations using Depth Stencil Textures even faster.
3. To our knowledge hardware PCF is used in the games implementing depth shadow maps using DST for supporting hardware.

In summary, it is on by default, because this way 3DMark05 score correlates better with real-world gaming performance for hardware that supports hardware PCF.

Q: How much does DST and hardware PCF accelerate the shadow rendering, compared to the non-DST path?

A: The DST and hardware PCF code path in 3DMark05 reads four samples from the depth map, then does the depth comparisons and takes a weighted average of these in a single shader instruction. To our knowledge, this process takes two clock cycles in the graphics hardware of at least one supporting IHV. The non-DST path does the same thing, but instead of a weighted average, it takes a straight average. In code, this is 14 shader instructions. Our estimate is that may take about 14 clock cycles. One IHV stated that some of their products can do all this in 7-8 clock cycles. The performance benefit is still remarkable, considering that actually more work is done in the DST/PCF code path. Taking a weighted average in the non-DST path would increase the amount of required shader instructions further.

Q: Why do the DST shadows look a bit different than those produced using the non-DST path?

A: These two depth shadow map implementations would give a more similar rendering, if we took the four point samples of the depth map from an area the size of a texel. We discovered, however, that increasing the sampling area produces a softer edge to the shadow. This can be done when using the non-DST implementation, but not using DST and hardware PCF. In some cases, like on the rock face of game test 3, the softer shadow edge makes the rendering look more natural to the eye. Thus, we naturally chose to use this non-DST implementation, instead of one that would be just as close as possible to the DST/PCF implementation. So, hardware PCF samples a smaller area, but the filtering is of higher quality, because it takes a weighted average of the depth map samples. The non-DST four point sample implementation uses a lower quality filtering (takes just an average, no weighting), but produces in Game Test 3 a rendering that usually looks more natural, due to the larger sampling area. Both implementations have their benefits and drawbacks. The difference between these is small, and you need to compare a frame with especially visible difference and do some magnification to see it, but there indeed is a difference.

Q: Why not use ATI's 3Dc then, if you're using NVIDIA's DST?

A: First of all, 3Dc and DST are two different features, there is no technical reason to compare these two. DST is a texture format for depth maps, while 3Dc is a texture compression format, especially designed for compressing normal maps. DST has been around for such a long time already and as described above, it is catching on in a big way amongst games. It has been available already before the launch of 3DMark2001. We had a working DST implementation in our engine already over a year ago. Now that DST is not an IHV specific feature anymore, we see no reason not to use it. Furthermore, looking from a game developer's perspective, DST is a hardware accelerated feature for rendering depth shadow maps. We did manage to create a non-DST path for the shadows, but the logical way to render depth shadow maps is using DST. – It should therefore be an obvious choice that DST is in use and by default.

3Dc on the other hand is (and seems to remain for quite some time) an IHV specific feature. Also, 3Dc would require a huge amount of additional artwork in the benchmark's downloadable package, while DST is just a few lines of code. 3DMark05 uses DXT5 (DirectX Texture compression 5) for compressing normal maps. DXT5 has been a DirectX feature since DirectX 8 (and long before that under the name S3TC), and is supported by all hardware capable of running 3DMark05. Looking at the still very few games using normal maps heavily, Doom 3 uses DXT5 for normal map compression, just as we do, so this is indeed what forward looking games do:
(http://www.gamespot.com/pc/action/doom3/news_6103458.html)

Q: Why did you not have 1) anti-aliasing 2) anisotropic filtering and 3) higher resolution as default? Games are usually played with these options.

A: We would have liked to use anti-aliasing and anisotropic filtering by default (4xAA, 8xAF), but as it is impossible to determine whether the driver really does AA & AF, we would have taken too big a risk in making them default settings. Even though 3DMark (or any other application) would ask for anti-aliasing or anisotropic filtering, the driver can fool the application. There is no way to ensure that the driver delivers the requested filtering or anti-aliasing. Our BDP members also agreed that AA & AF should remain optional settings for now. For those who want to use anti-aliasing and/or anisotropic filtering, we have options in the benchmark settings for that. This is available in both 3DMark05 Pro and Business versions.

We still continue to use 1024x768 as it is still the most used resolution in games. We made research into this prior to deciding the default resolution, and 1024x768 was by far the most used one. Again, we have options in the benchmark settings (3DMark05 Pro & Business versions) to raise or lower the resolution to the desired level.

Q: Is it fair that cards capable of SM3.0 default to SM3.0 and not to SM2.0? Doesn't this make comparing SM3.0 capable cards to cards only capable of SM2.0 pointless and "apples-to-oranges" comparison?

A: In 3DMark2001 and 3DMark03, we had Game Test 4 that required the latest shader version. In 3DMark05, we did not want to penalize shader model 2 hardware for the lack of a single feature. We wanted 3DMark05 to be more of a performance comparison tool. The solution HLSL offers, with different shader profiles is an elegant one. We can have a single set of shaders, compile them for the optimal profile for each hardware architecture, and still get the exactly same rendering as result.

We think it would have been worse to completely leave shader model 3 outside the default benchmark. shader model 3 may seem today like a single IHV feature, but the fact is, that 3DMark05 was developed for 3D performance benchmarking all the way to 2006 and beyond.

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Any Technical Questions Left Unanswered?

If you have any technical questions about the 3DMark05 which you would like to see added to this document, or need more information about of anything of the above, please contact us at:

Futuremark Corporation, http://www.futuremark.com

Mr. Nicklas Renqvist
Customer & Media Relations Specialist
Email: nick@futuremark.com

Futuremark Corporation
Kappelitie 6 D
FIN-02200 Espoo
FINLAND
Tel: +358-20 759 8250
Fax: +358-20 759 8251

Mr. Patric Ojala
Senior Manager, Benchmark Development
Email: patric@futuremark.com

Futuremark Corporation
Kappelitie 6 D
FIN-02200 Espoo
FINLAND
Tel: +358-20 759 8250
Fax: +358-20 759 8251