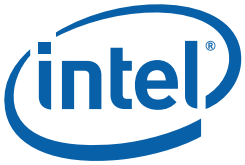

# Vertex and Geometry Processing Selection Capability for Microsoft DirectX* 10

**White Paper**

***For Intel® G45 Express Chipsets and Mobile Intel® GM45 Express Chipsets***

***November 2009***

Document Number: 322931-001

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## Figures

# Revision History

| Revision Number | Description | Revision Date |
|---|---|---|
| -001 | Initial release. | November 2009 |

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# 1 Introduction

The purpose of this document is to explain what the vertex and geometry processing selection capability is, and what the benefits are. The document is targeted for OEMs, system integrators, and end-users that will be building or using motherboards with Intel® G45 Express Chipsets; and Mobile Intel® GM45 Express Chipsets.

## 1.1 Terminology

| Term | Description |
|---|---|
| TnL | Transform and lighting |
| PSGP | Processor-Specific Geometry Pipeline: Code path that performs Vertex processing calculation on the processor inside the D3D runtime. |
| SWVP | Software Vertex Processing: Vertex Processing that takes place on the CPU utilizing the PSGP |
| HWVP | Hardware Vertex Processing: Vertex Processing that (traditionally) takes place on a graphics chip only |
| VGPSC | Vertex and Geometry Processing Selection Capability |

## 1.2 Reference Documents

| Document | Document No./Location |
|---|---|
| *Vertex Processing Selection Capability White Paper* | http://www.intel.com/design/chipsets/g965/documentation.htm#papers |

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# 2 Vertex and Geometry Processing Selection Capability

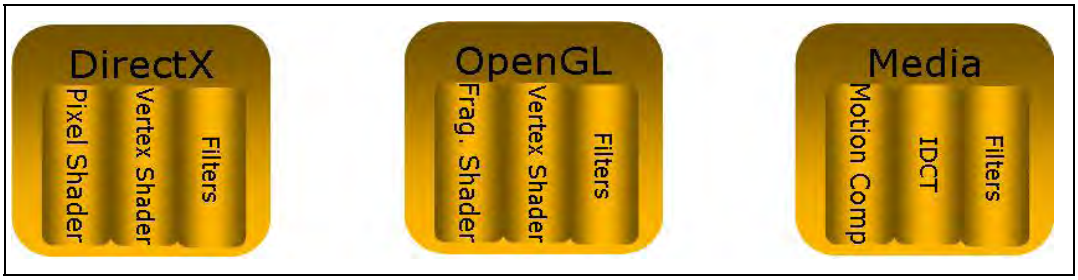
## 2.1 Introduction

Intel has released the 15.16 version driver for Microsoft Windows Vista* operating systems that includes support for Microsoft Windows* 7 operating systems. With the release of this driver, Intel further extends the capabilities of vertex processing for Microsoft DirectX* 10. With this technology, Intel is able to deliver a better gaming experience by adding additional platform performance in order to deliver higher frame rates and increased game compatibility.

## 2.2 Integrated Graphics Architecture

The Intel GMA HD architecture is based on a unified shader architecture that is comprised of a collection of highly-programmable, and scalable, 32-bit floating point engines. This programmable architecture is one based upon a unified shader model – which means both vertex, geometry, and pixels shaders run on the same programmable engines or execution units. These same programmable engines are also able to process media codecs, as well as various filters for text and image processing. The Intel graphics driver architecture delivers scalability and flexibility by supporting features within kernels that are compiled for the Intel graphics architecture. At the highest level, there are kernels that support 3D and media. Within 3D there are kernels for DirectX and SGI OpenGL*. DirectX then has kernels that support pixel and vertex shading, and filtering. OpenGL has fragment and vertex shading, as well as filtering kernels. The media kernels are codec dependent, but capabilities like IDCT (Inverse Discrete Cosine Transform), motion compensation, and filtering techniques like advanced de-interlacing would all be supported by a kernel. Figure 1. 3D and Media Kernels.

**Figure 1. 3D and Media Kernels**



## 2.3 Why Vertex and Geometry Processing Selection Capability?

In the process of designing and enabling a driver that supports Vertex Processing and TnL, Intel engineers discovered that some applications, mainly 3D games, performed better with vertex and geometry processing done on the processor rather than on the graphics engine. As mentioned above, the architecture uses the same programmable engines to process all shaders. By off-loading some of the vertex and geometry shader processing to the processor, the graphics engine is able to process more pixel shader data and do additional work like anisotropic filtering. Therefore, the graphics engine is able to do more while staying within market required power, thermal, and cost envelopes.

Separate vertex shader, geometry shader, and pixel shader units within the graphics engine were a potential design option for Intel graphics engines. However, upon analysis of various 3D applications, it was discovered that the vertex and geometry traffic is at the beginning of each scene, and only accounted for about one-third of the computing requirements for a scene. On the other hand, pixel traffic is about two-thirds of the scene and required most of the computing resources. So for much of the time the vertex shaders would be sitting idle.

## 2.4 Driver Architecture

In previous versions of DirectX, there was a path that allowed the processor to do vertex processing called the PSGP. Applications had to take this path into account and support a path for vertex processing on the processor and graphics cores.

Intel Engineers have developed a more optimized CPU vertex and geometry processing module and integrated it into the graphics driver, thus integrating the capabilities of the PSGP into the driver. When an application calls the D3D runtime environment (which then calls the graphics driver for vertex or geometry processing), the driver makes a decision to either have the processor or graphics engine process the workload. The processing of the data on either the processor or graphics engine returns the same result to the application. That is, Intel did not induce error or somehow change the data in a way that achieved additional performance beyond using a different engine to process the data. However, Intel did optimize the memory management of being able to swap data between the processor and graphics engines.

Determination as to which applications either process on the processor or graphics engine is based upon a list contained within the graphics inf that can be edited by Intel's customers. The list is based upon stringent application performance validation results. This technology has a huge benefit to the platform, as the best performance path can be used for 3D applications. Figure 2 shows the new path that utilizes VGPSC.

Intel also made this capability selectable by the end-user. Under the CUI (Common User Interface) there is a tab for 3D. The user clicks the box labeled "custom settings." Under the heading of Vertex Processing there are three options: Default, Application Settings, and Enable Software Processing. The default is Enable Software Processing. The CUI also has a help capability. The user can click the help button (? symbol) and then hover over a feature for a brief explanation of the feature, as shown

in Figure 3. If the “Enable Software Processing” option is enabled, then either the graphics engine or CPU is used depending on the application. If “Application Settings” is enabled, then the graphics engine is used for all vertex and geometry processing.

**Figure 2. Vertex and Geometry Processing Architecture**

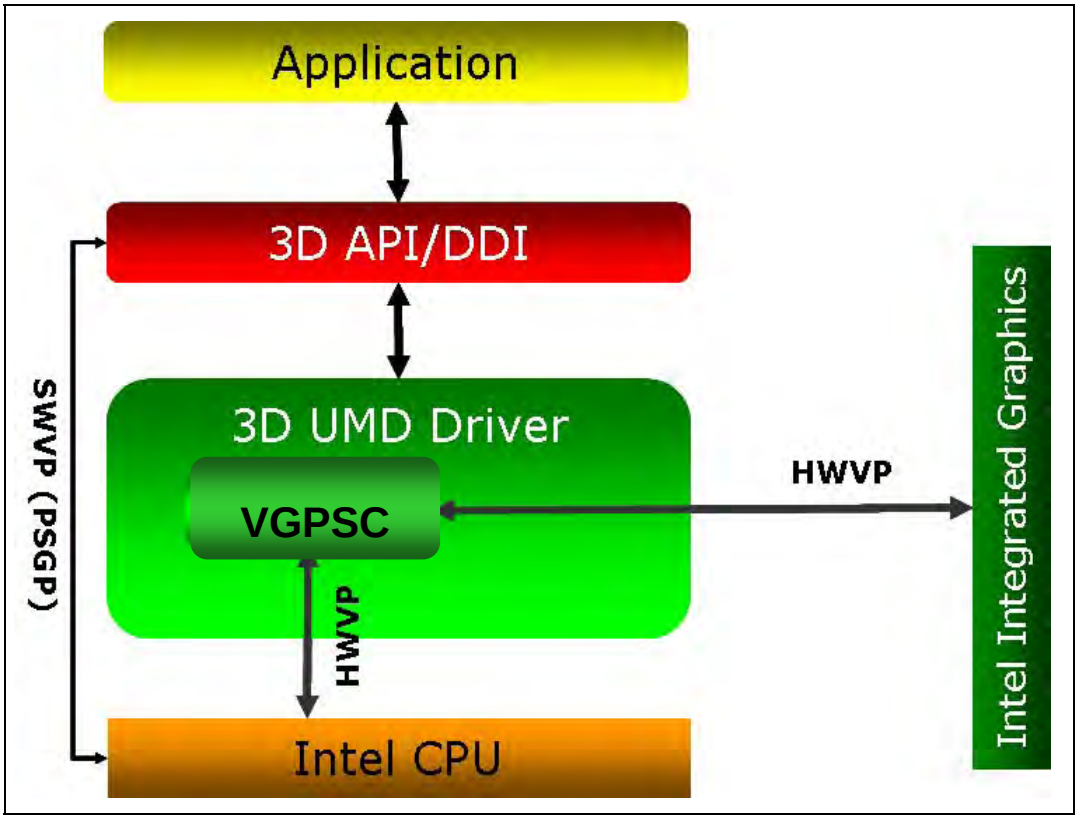
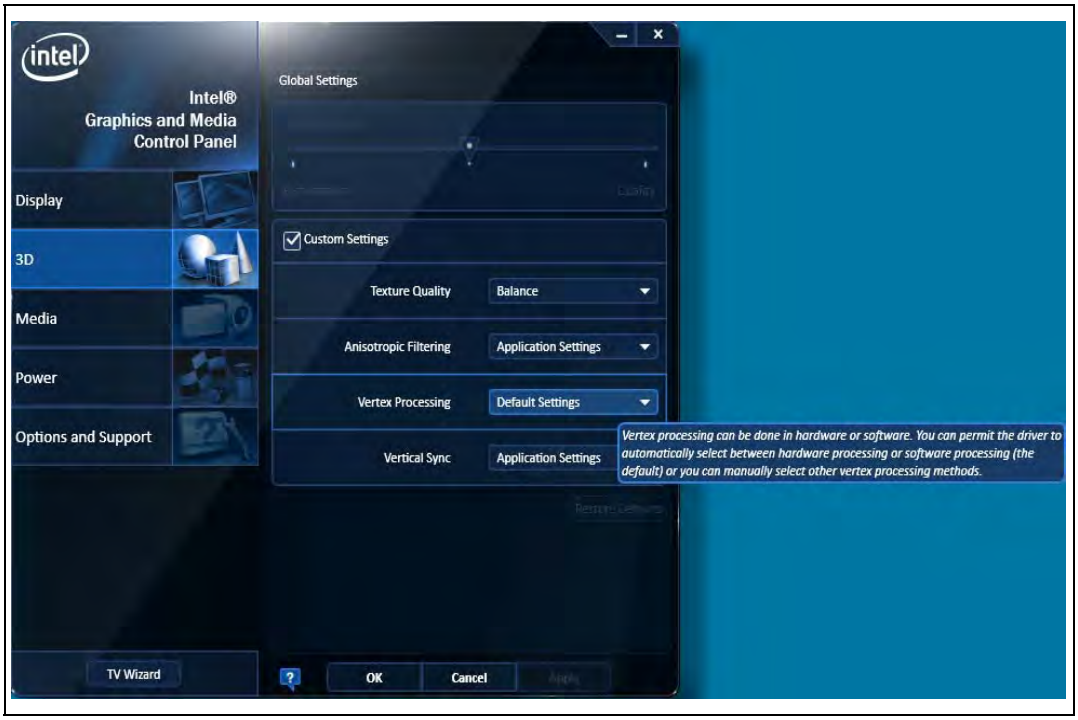


**Figure 3. Vertex and Geometry Processing Options in CUI**




## 2.5 Benefits of Vertex and Geometry Processing on Processor and Graphics Engines

The main motivation for this capability was to increase application performance on all Intel® 4 Series Express Chipsets. Intel had previously used this technology with DirectX 9 to increase the performance on Intel® 3 Series and Intel® 965 Series Express Chipsets. Figure 4 shows some games that benefit from having the processor compute the vertex and geometry data on Intel G45 Express Chipset with DirectX 10. The data shows that when the processor is used relative to using the graphics engine for vertex and geometry processing some applications perform better with the processor. Conversely, Figure 5 shows some applications that perform better using the graphics engine for vertex and geometry processing with DirectX 10.

**Figure 4. Intel® G45 Express Chipset Performance - Using Processor Accelerated Vertex and Geometry Processing with DirectX 10-based Applications**

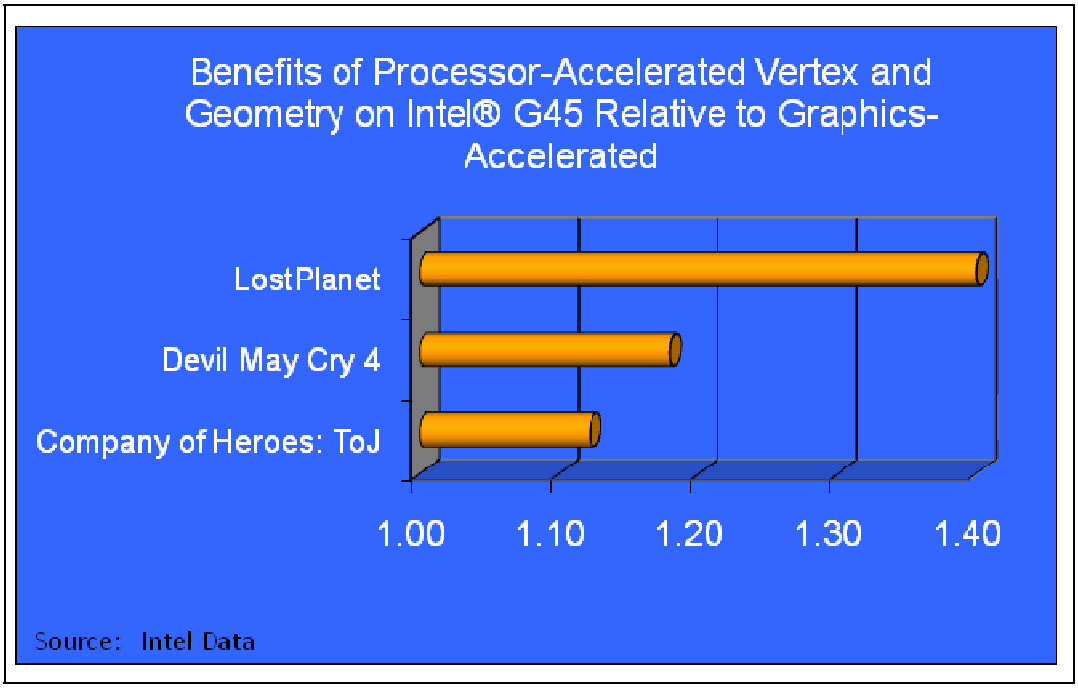
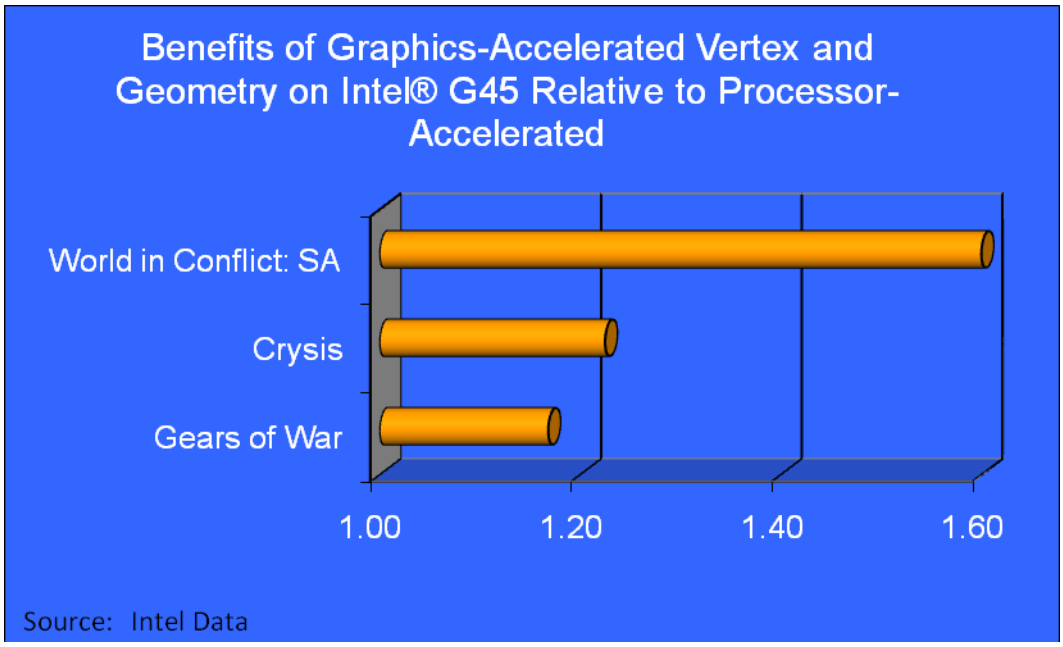



**Figure 5. Intel® G45 Express Chipset Performance Benefits - Using Graphics-Accelerated Vertex and Geometry Processing with DirectX 10-based Applications**



## 2.6 Summary

Intel has released graphic driver version 15.16 for Windows Vista operating systems with support for Windows 7 operating systems that extends the capabilities of the Vertex and Geometry Processing Selection Capability (VGPSC) for Intel Series 4 Express Chipsets. Results show that some 3D applications perform best with using the processor for vertex and geometry processing for DirectX 10. In other instances, results show that some 3D applications perform best with using the graphics engine on Intel G45 Express Chipset for DirectX 10. The Intel driver has been developed to provide the optimum performance path for 3D applications. Intel's goal is to provide the best user experience possible for 3D applications.

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