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Intel® Graphics Media Accelerator 900

White Paper

September 2004

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Revision History

Revision Number	Description	Revision Date
-001	• Initial public release	June 2004
-002	• Updated to include Intel® 915GV Express chipset	August 2004
-003	• Updated to include Intel® 910GL Express chipset	September 2004

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1   Introduction

With the release of the next-generation Intel® GMCH, the Intel® 915G/GV/910GL Express chipsets, a new graphics engine is introduced. Intel® Graphics Media Accelerator 900 (GMA 900) is the 3rd generation integrated graphics engine developed by Intel to meet the needs of both consumers and business users.

Intel GMA 900 provides consumers incredible visual quality, smooth video playback, and support for key 3D features without the extra expense of a discrete graphics card.

Intel GMA 900 provides business users the simplicity of graphics designed into the platform, while delivering stable, high-quality graphics needed in a business environment.

Intel GMA 900 offers driver support for a variety of operating systems - Microsoft Windows* 2000, Windows XP, Windows XP Media Center Edition, Mandrake Linux*, Red Hat Linux*, SuSe Linux*, Red Flag Linux*, and IBM OS/2*.

This paper introduces the graphics capabilities of the 915G/GV/910GL Express chipset and outlines the advantages of Intel GMA 900 graphics technology.

1.1   Reference Documents

Document	Document No./Location
Intel® 915G/915GV/915P Express Chipset Datasheet: For the Intel® 82915G/82915GV Graphics and Memory Controller Hub (GMCH) and Intel® 82915P Memory Controller Hub (MCH)	http://intel.com/design/ chipsets/datashts/301467.htm
Intel® Zone Rendering 3 Technology White Paper	http://intel.com/design/chipsets /applnots/302625.htm
Intel® 915G/GV/910GL Express Chipset Intel® Dynamic Video Memory Technology (DVMT) 3.0 White Paper	http://intel.com/design/chipsets /applnots/302623.htm

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2 Overview

2.1 Intel® Graphics Media Accelerator 900 Subsystem Overview

While the graphics subsystem for a discrete graphics device is mostly contained on a PCI, AGP, or PCI Express* Graphics card, the graphics subsystem in an integrated graphics solution, such as the Intel Integrated Graphics, uses the CPU, the GMCH, system memory, and different display interfaces.

As a result, Intel GMA 900 is designed to take full advantage of the power an Intel® Pentium® 4 processor brings to the PC. As will be discussed later, the CPU is used for the first stage of 3D processing (geometry operations), while the integrated graphics device handles the rest of the 3D processing.

Integrated into the 915G/GV/910GL Express chipset is Intel GMA 900 which provides 2D, 3D and video acceleration. The GMCH also provides display and memory interfaces critical to the Intel GMA 900 graphics subsystem.

Intel GMA 900 utilizes system memory for both system and graphics usage, balancing both usages for optimal performance. The 915G/GV/910GL GMCH supports up to two channels of DDR2 533 MHz memory in dual-channel mode, which provides peak bandwidth of 8.5 GB/s to be shared for system and graphics usages.

The 915G/GV/910GL GMCH also provides a variety of display interfaces. Intel GMA 900 graphics has an integrated DAC, two Intel® Serial Digital Video Out (SDVO) ports that can interface to DVI and LVDS transmitters, SD/HDTV-out encoders and additional DACs.

2.2 3D Graphics Processing

2.2.1 3D Graphics Pipeline

Intel GMA 900 is the next step in the evolution of Intel graphics. In addition to running the graphics engine at 333 MHz, Intel GMA 900 has four pixel pipelines which provide a fill rate of 1.3 GP/s, enabling an excellent consumer gaming experience.

The 3D graphics pipeline for Intel GMA 900 has a deep pipelined architecture in which each stage can simultaneously operate on different primitives (triangles) or on different portions of the same primitive. The 3D graphics pipeline is broken up into four major stages: geometry processing, setup (vertex processing), texture application and rasterization.

Intel GMA 900 graphics is optimized by using current and future Intel® processor family for advance software based transform and lighting (geometry processing) as defined by Microsoft Direct X*. The other three stages of 3D processing are handled by Intel GMA 900. The setup stage is responsible for vertex processing – converting vertices to pixels. The texture application

stage applies textures to pixels. The rasterization engine takes textured pixels and applies lighting and other environmental affects to produce the final pixel value. From the rasterization stage the final pixel value is written to the frame buffer in memory so it can be displayed.

2.2.2 3D Graphics Features

2.2.2.1 Zone Rendering Technology 3 (ZRT3)

Zone Rendering Technology 3 (ZRT3) is a tile-based rendering system designed to reduce memory bandwidth consumption and maximize rendering performance. To understand how ZRT3 works, it helps to first have a very basic understanding of conventional rendering.

With conventional rendering, a scene made up of various 3D models is sent to the graphics hardware where each model and its associated polygons are transformed from model space (the local coordinate system of each object), to world space (the coordinate system relative to the entire scene), and finally to view space (the viewer's coordinate system).Light values are then applied to the vertices of each triangle and then converted into pixel or screen coordinates. Each resulting pixel is the given texture color and is depth-tested to see if it will be visible or hidden by another pixel.

Since triangles are processed in the order they are received from the geometry engine (in the case of Intel GMA 900, the triangles are received from the processor), many pixels are written over several times due to other pixels being closer to the viewers perspective. This redundant rendering is memory bandwidth intensive and can result in non-optimal graphics performance.

ZRT3 aims to improve texture processing bandwidth by only performing texture processing on pixels that will be seen by the viewer (that are not hidden by other pixels). ZRT3 also strives to improve memory efficiency by reducing memory traffic and texture processing. Like conventional rendering, the scene is passed to the geometry processing engine where the polygons are transformed into view space. However, instead of then going directly through screen space conversion, Intel GMA 900 first sorts each polygon into memory, based on their location on the screen (zone). Since each zone can be processed entirely on-chip, the depth-testing and pixel blending operations are completed and the fully rendered zone is written out to the frame buffer – requiring each pixel to be written to memory only once.

The amount of memory bandwidth required to render a scene with conventional rendering can be significantly more than the amount required to render a scene with ZRT3. With ZRT3, the memory bandwidth consumption and improved performance will scale based on the depth complexity of a given scene. For more detailed information on ZRT3, please refer to the *Intel*® *Zone Rendering Technology 3 Whitepaper*.

2.2.2.2 Improved 3D Graphics Effects

Intel GMA 900 provides support for the latest 3D APIs resulting in improved 3D graphics effects. Below are examples of some SGI OpenGL* 1.4 and Microsoft DirectX 9.0 features supported by Intel GMA 900.

Lighting and Water Effects

Pixel Shader 2.0 delivers per pixel lighting techniques that increase visual detail and result in are more realistic environmental (lighting and water) effects.

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Shadow Effects

Shadow Maps are depth textures used for shadow effects. Shadow maps simulate soft shadows produced from area light sources resulting in more realistic shadow effects.

Two-Sided Stencil is a shadow volume rendering technique that reduces vertex bandwidth resulting in reduced performance impact while rendering high quality shadow effects.

Explosion and Fog Effects

Volumetric textures are textures that are used to represent 3D volumes. Volumetric textures produce more realistic environmental effects such as patchy fog and explosions.

Depth (Z) Coordinate Management

Slope Scale Depth Bias is a technique for applying a Z-Bias to objects that have the same Z value. Slope Scale Depth Bias results in less stitching – a common artifact caused by z-fighting.

2.3 Standard and High Definition Video Playback

Intel GMA 900 allows users to enjoy playback of Standard or High Definition content. The advanced de-interlacing technology provides improved quality of SD and HD video playback by improving upon BOB and WEAVE de-interlacing techniques for reduced jaggies and fewer weave artifacts.

2.4 Display Flexibility

Intel GMA 900 allows users to have many options in the kinds of displays that can be used - supporting CRTs (traditional computer monitors), Flat Panels, and Standard and High Definition Televisions. Additionally, Intel's new Dynamic Display Detect supports multiple wide aspect ratio display modes for viewing on the latest monitors, LCDs and digital displays.

2.4.1 Integrated DAC

Intel GMA 900 Graphics has an integrated DAC that can run up to 400 MHz allowing for support of QXGA resolutions (2048x1536 pixels) at refresh rates up to 85 Hz for analog displays (e.g., traditional CRTs).

2.4.2 Intel® Serial Digital Video Out Ports

The two Intel Serial Digital Video Out (SDVO) ports that are integrated onto 915G/GV/910GL GMCH are multiplexed onto the PCI Express x16 Graphics interface. The multiplexing of the Intel SDVO ports onto the PCI Express x16 Graphics interface allows for digital displays support to be added to the platform by installing an Advanced Digital Display (ADD2) card into the PCI Express x16 Graphics connector. ADD2 cards implement the required circuitry for additional display connectivity onto a card that is easily installed in the system.

Each SDVO port runs at a pixel rate of 200 MP/s. The two ports can be combined to work together as a single port with an effective pixel rate of 400 MP/s. The 400 MP/s pixel rate allows for support of QXGA resolutions (2048x1536 pixels) at refresh rates up to 85 Hz.

Intel SDVO ports can interface to codecs that enable support for LVDS panels, DVI-I and DVI-D displays, standard- and high-definition televisions and CRTs.

2.4.3 Intel® Dual-Display Configurations

Intel GMA 900 graphics has two, independent display pipelines which allow for users to operate the system with up to two displays driven by the integrated graphics device. The displays can be driven in a few different configurations which are detailed in the following sections.

2.4.3.1 Intel® Dual-Display Clone

Intel® Dual-Display Clone is used to drive multiple displays with the same content. Each display device can be configured independently, allowing each to have a different refresh rates for optimum display on each device. Intel Dual-Display Clone is beneficial when using displays of various types, such as one pipe driving a Digital display while the other drives an analog overhead projector that may only support specific refresh rates.

2.4.3.2 Intel® Dual-Display Twin

Intel® Dual-Display Twin is similar to the Intel Dual-Display Clone mode, except it is driven by a single pipe which only allows same content, color depth, resolution and refresh rate.

2.4.3.3 Extended Desktop

Extended Desktop is used for multi-monitor to allow for a larger desktop that spans multiple displays, creating more screen real estate than a single display provides. Application can be moved from one monitor to another, or can be on more than one monitor simultaneously.

2.5 Graphics Memory

2.5.1 Graphics Memory Bandwidth

As part of the Intel GMA 900 graphics subsystem, system memory is leveraged for both system and graphics usages. Since memory is shared by both graphics and other system applications, memory bandwidth is important in delivering a quality user experience. The 915G/GV/910GL Express chipset allows for memory support up to dual-channel DDR2 533MHz which provides 8.5 GB/s peak memory bandwidth. With up to 8.5 GB/s of memory bandwidth available, Intel GMA 900 can deliver a high-quality user experience.

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Table 1. Memory Bandwidth

Memory Type	Memory Speed	Dual Channel Bandwidth
DDR2	533 MHz	8.5 GB/s
DDR2	400 MHz	6.4 GB/s
DDR	400 MHz	6.4 GB/s
DDR	333 MHz	5.4 GB/s

2.5.2 Intel® Dynamic Video Memory Technology 3.0

Intel GMA 900 utilizes a shared memory architecture – system memory is used for both graphics and system usages. Instead of using dedicated local memory, like the majority of discrete cards today, a portion of the system memory is allocated for video memory. Intel Dynamic Video Memory Technology 3.0 (DVMT 3.0) allows additional memory to be allocated for graphics usage based on application need. Once the application is closed, the memory that was allocated for graphics usage is then released and made available for system use. Dynamically allocating memory for graphics use ensures a sold balance between system and graphics performance.

DVMT 3.0 allows up to 224 MB of system memory to be either shared amongst the OS, applications and graphics display or solely dedicated to graphics. Also included in the enhancements are options to select "Fixed" mode, "DVMT" mode or "Fixed + DVMT" mode, dependent upon the total graphics memory configuration. "Fixed" mode is non-contiguous page-locked memory allocated during driver initialization to provide a static amount of memory. "DVMT" mode is memory that is dynamically allocated based on memory requests made by application and are release back to the system once the requesting application has been terminated. "Fixed + DVMT" mode, allows the combination of both "Fixed" and "DVMT" type driver allocation methods, used to guarantee a minimum amount of memory but give the flexibility of "DVMT" allocation scheme and performance enhancement. These mode options will ensure that a certain minimum amount of memory will always be dedicated to graphics. Also included is the option to select "Maximum DVMT" mode which allows up to 224 MB of memory to be allocated for graphics. Below is a list of the different memory configurations that are available. For more detailed information on DVMT 3.0, please refer to the *Intel® 915G/GV/910GL Express Chipset Intel® Dynamic Video Memory Technology (DVMT) 3.0 White Paper*.

Table 2. Intel® DVMT 3.0 Configuration Options

System Memory	Max Fixed Memory Allowed	Max DVMT Memory Allowed	Max "Fixed + DVMT" Memory Allowed	Notes
128 MB	32 MB	32 MB	N/A	
256 MB	128 MB	128 MB or Maximum DVMT	64 MB + 64 MB	See Note 1
512 MB	128 MB	128 MB or Maximum DVMT	64 MB + 64 MB	See Note 2

NOTES:
1. When the "Maximum DVMT" option is selected for System Memory less than or equal to 511 MB, the Maximum Graphics Memory reported will be 160 MB.
2. When the "Maximum DVMT" option is selected for System Memory greater than or equal to 512 MB, the Maximum Graphics Memory reported will be 224 MB. §

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3   *Summary*

Intel Graphics Media Accelerator 900 (GMA 900) is Intel's third generation graphics engine which raises the baseline for integrated graphics technology meeting the needs for both consumers and business users.

Intel GMA 900 is a balanced graphics solution that adds support for the latest APIs and delivers innovation with a new graphics architecture and display technologies to deliver incredible visual quality and stability.

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