



Radeon X1000 Family Technology Overview



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The Radeon X1000 family is the most powerful and technologically advanced line of graphics processing units ever created. It was designed to deliver the fastest frame rates and best image quality in the latest 3D games. It was also designed to be expandable and ready to enable the next generation of game, video, and display technologies.

The Radeon X1800, Radeon X1600, and Radeon X1300 are the first products to use this new graphics architecture from ATI. Technology highlights include:

90 Nanometer Technology

- Faster clock speeds
- Double the transistor density of earlier 130nm technology

New Performance Architecture

- High efficiency Ultra-Threaded Pixel Shader Engine
- Supports Shader Model 3.0 at speeds several times faster than any existing technology

New Memory Controller Design

- Supports the fastest available memory speeds
- New cache design, latency improvements

Next-Generation Image Quality

- Advanced High Dynamic Range rendering, 128-bit floating point precision
- Extreme anti-aliasing and texture filtering quality

Avivo™

- Revolutionary display, video, and connectivity capabilities
- Consumer electronics convergence features

CrossFire™

- Powerful parallel graphics processing support



Radeon X1800 XT

Graphics Trends

The Radeon X1000 family architecture was designed based on a number of industry trends:

Resolution and Fill Rate

Digital Flat Panel (DFP) displays have grown rapidly in popularity in recent years. One important characteristic of DFP displays is that they have a limited native resolution. The vast majority of DFP displays sold to date have native resolutions of 1280x1024 or lower, while most traditional CRTs can handle maximum resolutions of 1600x1200 or higher.

This trend means that it is no longer possible to assume that image quality can be scaled up by simply increasing resolution and rendering more pixels. Previous generations of GPUs could rely on increasing the number of rendering pipelines to increase fill rate (pixels per second), and thus improve frame rates at higher resolutions. For the new generation of GPUs, it has become necessary to find other means of improving image quality and performance.

Dual Core CPUs

While GPU performance has increased dramatically over the past few years, improvements in CPU performance have been much more gradual. The result of this trend is that 3D application performance has in general become steadily more CPU-limited and less GPU-limited. The recent introduction of dual core CPUs promises to help break through this performance plateau, and provide significant improvements as software takes greater advantage of multithreading optimizations.

The new generation of GPUs must be able to deliver better image quality per frame on existing CPUs, and also have additional power to take advantage of dual core CPU performance as they become more prevalent.

DirectX 9 Shader Performance

The ability to execute complex DirectX 9 shader code quickly and efficiently is increasingly becoming the key determinant of performance in 3D games. DirectX 9 includes a number of shader models that expose different sets of features and instructions. The latest iteration, Shader Model 3.0, does not significantly change the programming model relative to Shader Model 2.0. However, it does provide new opportunities for optimization, with support for capabilities like dynamic flow control.

Shader Model 3.0 will provide a stable platform for development of the next generation of PC games. The introduction of new gaming consoles that support Shader Model 3.0 to the market in coming months should further encourage creative and optimal use of this programming interface. The new generation of GPUs can best take advantage of this trend by putting a strong focus on Shader Model 3.0 performance.

Quantity and Quality of Creative Content

Great graphics start with great artwork. Creative assets such as texture, polygon, and animation data determine how much detail can be included in a 3D game. One of the most obvious ways to improve visual quality is to use a wide variety of high resolution content. However, working with this content creates an insatiable demand for memory and bandwidth on the GPU.

To handle the huge amounts of high quality artwork that will define the next generation of games, the new generation of GPUs will need to be supported by large amounts of high

performance graphics memory. Specialized memory technologies, such as GDDR3, have appeared to meet this demand. Taking full advantage of these new technologies requires an efficient memory controller design that can scale up to higher clock speeds, and ensure that massive amounts of data can be moved rapidly throughout the chip.

High Dynamic Range

High Dynamic Range (HDR) rendering is one of the most popular new image quality and realism-enhancing features of the latest games. It makes use of specialized data formats to more accurately capture the full range of brightness and color that the eye can perceive.

Working with HDR requires high performance, full precision floating point rendering capability. Since HDR data formats can contain more information than standard quality data formats, they demand generous amounts of memory and bandwidth. The new generation of GPUs should be ready to handle these demands. It is also very important that they be capable of HDR rendering together with other established image quality techniques, such as anti-aliasing.

Convergence and New Display Technologies

All of the industry leaders in PC and Consumer Electronics devices are investing heavily in convergence technologies, which bring together the advantages of both areas and improve interoperability. As Media PCs increase in popularity, it is becoming more important than ever for graphics cards to provide robust support for displays other than PC monitors. The GPU plays a central role in accelerating and enhancing the display of high quality video in all formats, on a wide variety of display devices.

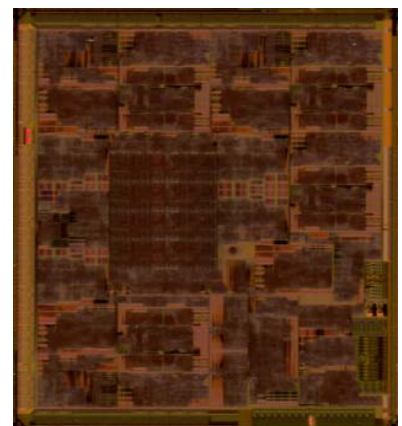
Scalable Graphics

There has been a recent resurgence in interest in PC configurations with multiple GPUs to drive higher performance. This trend has been driven by the emergence of PCI Express platforms, and by the growing importance placed on GPUs as a system component. The new generation of GPUs should be ready to work in parallel with other processors, and optimized to deliver the maximum benefit in these configurations. The Radeon X1000 Family was designed from the ground up to address these trends, providing the ideal GPUs for all PC users.

90 Nanometer Technology

The Radeon X1000 family includes the world's first GPUs to be manufactured on a 90 nanometer (nm) fabrication process by Taiwan Semiconductor Manufacturing Co. (TSMC). By reducing the dimensions of each transistor, this process enables devices with unprecedented density. Up to twice as many transistors can be packed into a given area compared to the previous generation 130nm process, and substantially higher clock speeds become possible. The process is also designed to operate at lower voltages, so each transistor consumes less power when running at equivalent clock speeds.

Comprising over 320 million transistors, the Radeon X1800 is the most complex and powerful consumer processing device ever developed. This represents a doubling of transistor count relative to the previous flagship ATI GPU, the Radeon X850. The Radeon X1800 is also the first GPU to ship with a clock speed exceeding 600 MHz, and the first



RADEON X1800

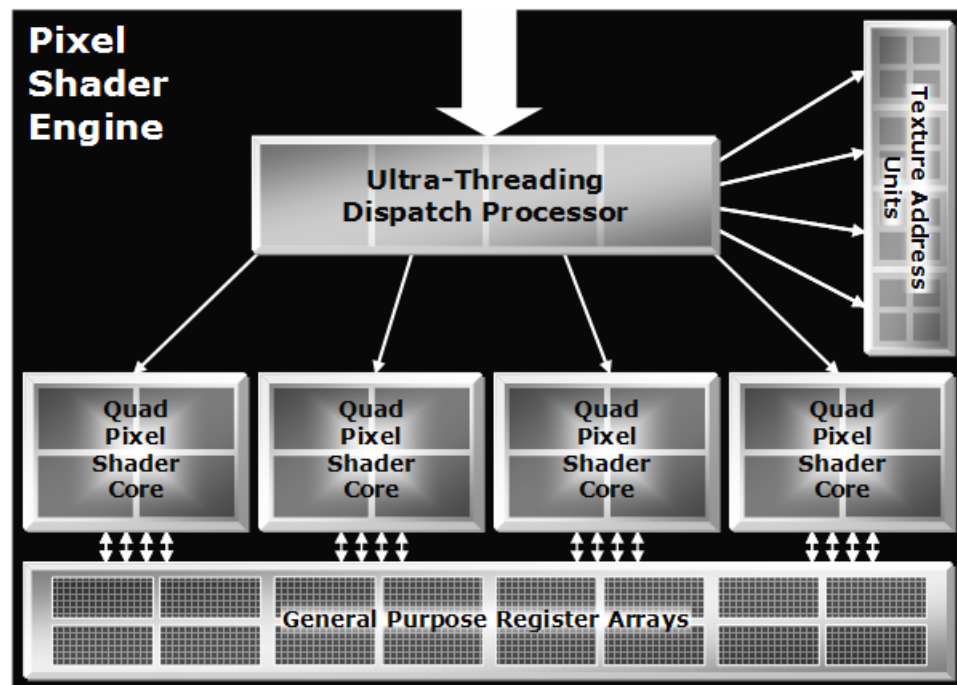
to support 800 MHz GDDR3 memory devices. All of this is made possible by new microprocessor manufacturing technology.

At 157 million transistors, the Radeon X1600 is approximately half the size of the Radeon X1800, but is generally able to deliver more than half the performance while still offering the complete feature set of its high-end sibling. The Radeon X1300 takes advantage of 90nm technology to become the first entry-level GPU to break the 100 million transistor mark. These products offer a price-performance ratio and feature set previously unheard of in their respective classes.

To keep power consumption and heat generation under control, the Radeon X1000 family of GPUs make use of Dynamic Voltage Control technology. Increasing the voltage of a microprocessor can allow higher clock speeds and performance, at the price of increased power consumption and heat output. A GPU typically needs to operate at its highest possible speed only when performing heavy 3D graphics rendering, and lower speeds can suffice when performing less graphics-intensive tasks like web surfing or word processing. Dynamic Voltage Control allows voltage to be automatically scaled as required, thus minimizing heat and power consumption whenever possible.

Ultra-Threaded Pixel Shader Engine

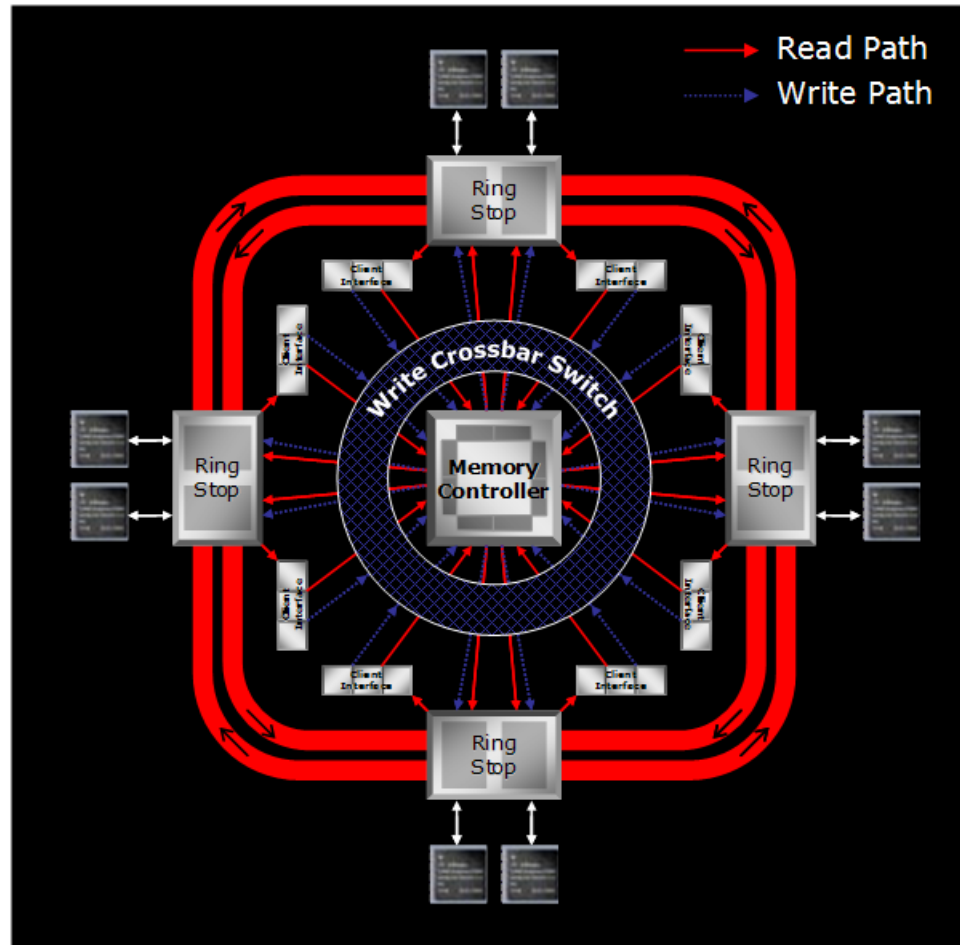
The Radeon X1000 Family features an Ultra-Threaded Pixel Shader Engine capable of handling up to 512 threads at once. This design minimizes wasted processing cycles, and delivers well over 90% efficiency for shader processing. The shader engine is optimized for Shader Model 3.0, with fast dynamic branching and full speed 128-bit floating point rendering. The future-looking design provides the highest performance in the latest games, and is ready to deliver outstanding frame rates in upcoming titles as well.



Radeon X1800 Pixel Shader Engine

New Memory Controller Design

The flagship Radeon X1800 GPU incorporates a new memory controller designed to support the fastest available graphics memory devices. The 256-bit memory interface is divided into 8 32-bit channels, twice as many channels as previous designs, to make better use of available bandwidth. This is coupled to a 512-bit internal ring bus to simplify design and enable extreme memory clock scaling. The memory controller features programmable arbitration logic, which uses a feedback system to maximize memory efficiency, and can be improved over time via driver updates. The design also uses new fully associative caches along with better compression and hidden surface removal techniques to provide more optimal memory performance.



Radeon X1800 Memory Controller

The mid-range Radeon X1600 GPU incorporates a memory controller with all of the same features as the Radeon X1800, except that the memory interface and ring bus are half as wide (128 bits and 256 bits, respectively).

The entry-level Radeon X1300 is the most flexible product in the line-up, capable of supporting 32-bit, 64-bit, and 128-bit memory interfaces (1, 2, or 4 32-bit channels, respectively). Its relatively simple design, with fewer memory clients than the X1600 or X1800, does not necessitate inclusion of a ring bus or programmable arbitration logic. However, it does make use of fully associative caches as well as new compression and hidden surface removal techniques to optimize performance.

The Radeon X1300 also features support for HyperMemory 2, ATI's second generation virtual memory management technology. With improved efficiency for data transfer over the PCI Express bus, HyperMemory 2 allows rendering to system memory as if it was local graphics memory, thus enabling high performance, low cost product configurations.

Image Quality

The Radeon X1000 family builds in extensive support for HDR rendering to deliver more vibrant, realistic images. This technique provides the most visible and significant image quality improvement in the upcoming generation of games. The X1000 product line is the first that can combine 64-bit floating point HDR rendering with fast multisample anti-aliasing.

New adaptive anti-aliasing and high quality anisotropic filtering methods are also employed to provide higher quality and better frame rates than ever before. Better still, these methods are fully compatible with HDR to provide uncompromised visual quality.

In addition, 3Dc+ provides high quality texture compression for a wider range of texture formats. This will allow game developers to optimize frame rates without affecting image quality, or use a wider variety of textures without consuming additional graphics memory.



Image from Alan Wake, an upcoming game from Remedy Entertainment

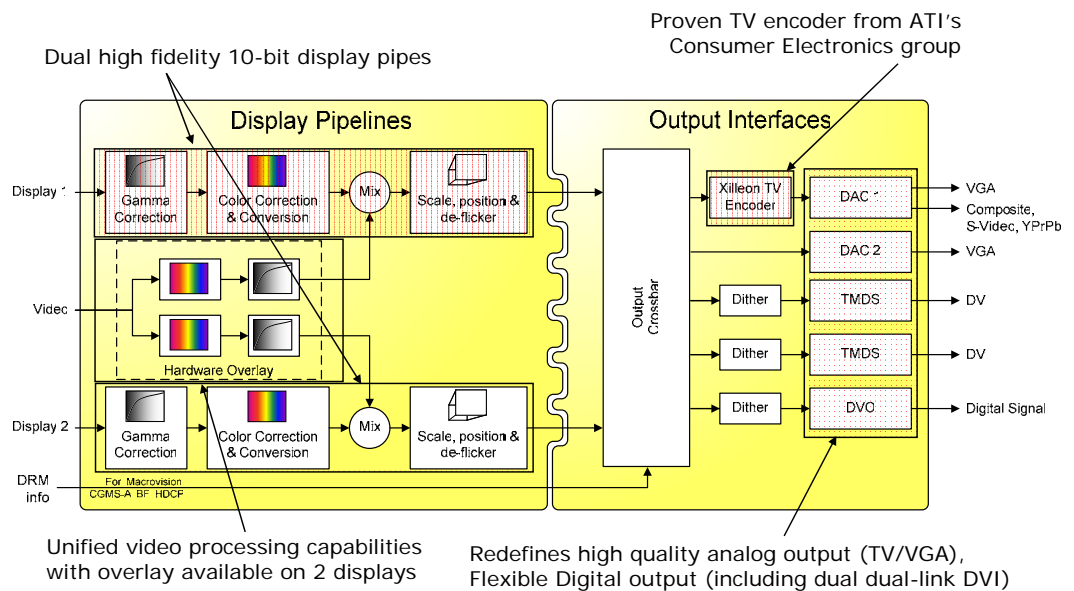
Avivo

The Radeon X1000 family of GPUs all include a brand new display engine and video processing capabilities featuring Avivo technology. It addresses the latest trends toward media and consumer electronics integration, providing high quality analog and digital display connectivity along with full support for standard and high definition video formats. Its PC display capabilities are second to none, overcoming all the limitations of previous products. The

engine is compatible with all of the latest LCD display technologies that feature higher resolutions, new aspect ratios, faster response times, and higher color depths.

The Avivo Display Engine incorporates a wide range of features designed to perfect the image and video display experience. All products in the family support dual 10-bit display pipelines, each with independent high quality gamma correction, color correction, video overlays, scaling, and de-interlacing technologies. The integrated TV encoder uses the same Xileon technology ATI developed for high-end HDTV sets, and the temporal/spatial dithering features allow low cost LCDs to display a dramatically increased range of colors.

The Radeon X1000 family is also ready for upcoming video formats and display formats. In particular, it is the first product line capable of accelerating encoding, decoding, and playback of H.264 and VC-1 codecs, which will form the basis of the next-generation Blu-Ray and HD-DVD formats.




Avivo Display Engine

CrossFire

The Radeon X1000 Family features support for an updated version of ATI's breakthrough CrossFire multi-GPU technology. By combining a Radeon X1000 Family CrossFire Edition or CrossFire Ready graphics card with a second compatible Radeon X1000 Family graphics card, in a Radeon Xpress 200 CrossFire Edition motherboard with dual PCI Express graphics slots, it is possible to achieve up to double the frame rates of a single card, and achieve new levels of image quality. CrossFire automatically selects one of three modes of operations (Alternate Frame Rendering, Supertiling, or Scissor) to efficiently split the rendering workload of any 3D game between the two GPUs. Alternatively, users can select one of the new Super AA modes that combine the results from each GPU to improve image quality significantly.

The latest iteration of CrossFire technology provides further enhancements to the original implementation. The new Compositing Engine on Radeon X1800 and Radeon X1600 CrossFire Edition boards now accelerate the blending step of the process used for the Super AA modes, delivering major increases in frame rates. Also, improvements to the DVI interlink used to connect the two GPUs allow CrossFire configurations to drive the latest ultra-high resolution



digital and analog displays. Finally, CrossFire support has been extended to the entire product family with the introduction of the Radeon X1300, which now supports dual-card configurations without requiring a DVI interlink.

Summary

The Radeon X1000 family of graphics processing units take advantage of a new architecture and the latest advancements in semiconductor manufacturing technology to provide the ultimate in performance and image quality for any PC user.

The RADEON X1800 Series is designed for serious gamers and professionals who demand the ultimate in graphics performance and image quality. It delivers up to two times the performance of the Radeon X850, a feat made possible by cutting edge 90nm technology and an innovative new 3D architecture optimized for Shader Model 3.0. Featuring industry-leading HDR support along with breakthrough display and video quality features, it represents the new state of the art in GPU design.

The Radeon X1600 Series is designed to deliver the best balance between 3D performance and cost, while maintaining the full feature set of the high-end X1800 Series. It allows the new generation of games to be experienced in their full glory without making a large investment, and its outstanding video and display capabilities make it the ideal foundation for Media PCs.

The Radeon X1300 Series is designed to provide great 3D performance at an unbeatable price. Easily outperforming all previous products in its class, the X1300 Series also supports the widest range of product configurations to meet the needs and the budget of any mainstream PC user.

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