ATI XGP™ Technology

Technology Brief

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INTRODUCTION

As graphics requirements in today's systems keep rising, the demands on the system designers to provide enough bandwidth, power and cooling to support the new graphics processors and higher speeds graphics memory becomes more and more of a challenge.

To successfully design such a system, tradeoffs are constantly being made.

- For laptops, battery life and space/cooling constraints impact how fast graphics can be pushed. This potentially limits the functionality of a laptop or can cause a laptop to be oversized while affecting battery life.

- In desktop and workstation systems, the pre-heated air flow within the standard form factors plus the exceedingly large power supplies necessary to support high performance graphics in parallel to high-end CPUs and other devices have the potential to drive up the system costs and introduce higher than desired noise levels. It can also increase the physical size of the systems.

For these reasons, laptops users tend to turn to a separate desktop computer to support gaming and high-end graphics applications. The laptop itself tends to be replaced more often due to limitations and the inability to upgrade its graphics system as needed. Even in the best case, the laptop user typically has to settle for less performance or larger and heavier laptop systems.

For the desktop and workstation market, high-end graphics cards often cannot be installed into an existing system due to insufficient air flow, inadequate power supply, or lack of slots for ATI CrossFireX™ GPU configurations. So the system either has to be replaced or stay limited in its performance.

The high-end desktop and workstation systems can reasonably support the high-end graphics cards of today but usually require the use of expensive 1000 Watt or larger power supplies, fancy air flow control or exotic liquid cooling methods, and often louder fan systems.

BACKGROUND

As graphics performance has grown, the industry has typically taken two approaches to support the ever increasing support requirements — internal design modifications/tradeoffs or adding external graphics.

Bandwidth Requirements

It is useful to first understand some bandwidth requirements for today's moderate and high-end graphics.

Microsoft Windows Vista® Aero Requirements : Microsoft Windows Vista has pushed the graphics requirements higher, even for just basic desktop usage. Microsoft recommends that at least four lanes of PCI Express (PCI-E) are available to enable all the Aero features. A single lane of PCI-E bus capability will cause Aero features to be disabled for all but the lowest resolutions.

The 'Windows Hardware Logo Program Requirements' (dated March 21st, 2008) lists in the Graphics-0057 requirement for the BASIC logo that PCI Express graphics solutions must implement with a four lane width (both directions) if they are the primary graphics display. The document does list an exception allowing for x1 lane width for a Basic class system but the emphasis is on 4 lanes or more to allow for the full implementation of the Aero interface.

High-End Graphics Card Requirements : With cards such as the ATI Radeon™ HD 3870 X2 (dual GPU) or the ATI Radeon™ HD 3870 (single GPU), depending on the host system CPU and system memory, having less than eight lanes of PCI-E 1.1 bandwidth can be expected to show a noticeable drop in performance. For dual GPU type cards, some applications are now able to take advantage of 16 lanes PCI-E 1.1 or eight lanes of PCI-E 2.0 of bandwidth.

Taking one of the highest performance cases, for two ATI Radeon HD 3870 cards running in CrossFireX mode (somewhat similar to an ATI Radeon HD 3870 x2), comparing 8 vs 16 lanes in a desktop configuration[1] with high-end CPUs (this tends to make the bus or GPU the limitation), we see performance variances between +5.1% to -22.2% in common benchmarks and game scenarios[2]. Most cases are in the 0 to 5% variance in favor of the sixteen lane bus.

Eight lanes PCI-E 2.0 will typically give most of the performance needed for these examples. But as can be seen, there is some limitation being seen at the 8 versus 16 lanes. A reduction below 8 lanes can be expected to substantially drop the performance on any demanding game with high-end cards. Eight lanes however will in most cases allow excellent GPU performance. For very high-end systems such as workstation render system, the 16 lane ATI XGP option may be preferred.

Midrange Graphics Card Performance : A similar type test[3] was done comparing PCI-E 1.1 vs PCI-E 2.0 impact but with a midrange single GPU card (ATI Radeon™ HD 3650 Pro). This testing shows even less difference between eight and sixteen lanes (0 to 5%). The PCI-E 1.1 sixteen lanes is equivalent to approximately PCI-E 2.0 eight lanes (x2 speed). What this amounts to is that the eight lane ATI XGP cable can be expected to enable full performance for mid range GPUs.

Most of the bandwidth currently used is in the host system to GPU path. In addition, low-latency response times and good-burst speeds are needed for GPU communication back to the host system. For ATI CrossFireX configurations and other future technologies in current development, the GPU-to-host system path demands will increase, potentially matching or even eclipsing the host-to-GPU path.

To illustrate different bandwidth requirements based on today's PCI-E graphics cards, Table 1 gives some examples of bandwidth usage in both directions on the bus. The numbers given are for PCI-E 1.1 lane width.

[1] High-End Testing System Configuration: 2 ATI Radeon HD 3870 Cards in CrossFireX Mode; GPU clock @ 777 MHz, memory clock @ 1125 MHz; ASUS P5E (X38) system with X9650 CPU @ 3 GHz; 2GB DDR2-800 5-5-5-12 system memory; Windows Vista RTM 64 bit

[2] This is a partial list of the benchmark and game software used for the test results given here; 3DMark 2006, Call of Duty 4, Fear, Company of Heros, Unreal Tournament, Call of Juarez, Crysis

[3] Mid-Range Testing System Configuration: 1 ATI Radeon HD 3870 Card; GPU Clock @ 725 MHz, memory clock @ 800 MHz; ASUS M3A32-MVP (790FX) with AMD Phenom 9600 (2.2GHz) and 2GB DDR2-800 5-5-5-12 system memory; Windows Vista RTM 64 bit

Table 1 : Estimated PCI-E 1.1 Bus Usage

	CPU to GPU (lanes)	GPU to CPU (lanes)
Microsoft Windows Vista® Aero graphics	4	4
Display Reuse	<1	~3
ATI CrossFireX™ (software)	<1	~3
Mid Range GPU Normal Function *[1]	3	<1
Mid Range Dual GPU Normal Functions	6	1
Very high-end Dual GPU or Quad GPU Functions *[2]	8 to 16	1

Note 1 : sample of a mid range GPU : ATI Radeon™ HD3650
Note 2 : sample of a very high-end dual GPU : ATI Radeon™ HD 3870 X2

A single lane of PCI-E 1.1 offers data rates of 2.5 Gbits/s (or 0.25 Gbytes/s) in each direction independently. The following table shows the bandwidth of PCI-E 8- and 16-lane buses. These are the theoretical maximum data transfer rates and will be lower in real applications. To roughly convert PCI-E 1.1 lane count requirements to PCI-E 2.0 lane count requirements, simply divide the number by 2.

Table 2 : PCI-E Available Bandwidth (each direction)

PCI-E Lanes	Ver 1.1	Ver 2.0
8x	2 GBytes/s	4 GBytes/s
16x	4 GBytes/s	8 GBytes/s

The Internal Design Approach

The space and battery life constraints have forced laptop designs to typically focus primarily on performance tradeoffs.

To help maximize the battery life of a system, it is necessary to cut the power used when running without AC power. Some of the common approaches have been:

- More efficient graphics processor designs
  - process improvements/shrinkage
  - architectural enhancements
- Sorting and selecting GPUs specifically for low leakage parts (IE: lower power consumption)
- Adjusting voltage and clock speeds down (such as is done with ATI PowerXpress™ technology)
- Combinations of lower performance but power-efficient IGP (internal graphics processor) and a separate discrete GPU
- Improved cooling to keep GPUs running at more efficient temperatures

Unfortunately, while small geometries and other enhancements have helped with power consumption, transistor count increases along with clock speeds of the GPUs and their memories have outpaced the energy savings achieved. Some high-end gaming laptops have been able to partially accommodate these increased power and thermal demands by way of larger and heavier laptops with improved cooling systems and limited battery life. But none have been able to match the performance of a desktop system. Standard laptops are even more restricted due to their size and battery life compared to the so-called gamers' laptop.

The External Graphics Approach

An approach that has been looked at for years, but with little success, has been to take the graphics system outside of the primary computer. This method has the advantage of allowing the graphics system to be optimized both in its customized form factor and thermal solution.

For the mobile market, this allows the laptop to have improved battery life and reasonable graphics performance when running on battery power. When the laptop is plugged into AC power, through the use of external graphics the laptop could in theory achieve equivalent or even greater graphics performance than that of a desktop system.

For the desktop and workstation systems, an external graphics solution allows a low cost power supply to be in the primary system combined with a simple cooling design and small form factor. The system no longer has to be designed for the worse case power and cooling requirements. This would also allow a system to receive even more powerful graphics upgrades and other multi-media capabilities thus extending its potential life expectancy.

For both the mobile and desktop markets, an external graphics solution could also be shared among multiple systems (i.e.: each using the graphics unit exclusively for a period of time) allowing for high end graphics performance and potentially lower overall system costs.

Display Port Replicators

Some early external graphics devices were designed not to increase performance, but instead to increase the number of displays that could be attached. These devices either were connected between the graphics output and the monitor or onto an external non-graphics bus.

The original units were designed for laptops and were attached to the PCI bus through PC cards on some laptops. More recently, units have been introduced that use the USB 2.0 bus or the a single PCI-E lane from the newer PCI Express cards

Due to the capacity limit of all of these solutions, actually doing any reasonable amount of rendering is not practical with these devices. They remain restricted as primarily display port replicators. In fact, due to the need to support additional displays from a single graphics processor, frame rate and/or image detail performance can degrade for any complex rendering application.

Docking Stations

Some docking stations have been designed to do more than just add extra display ports. In the latest generation, some stations allow for insertion of a single small form factor PCI-E card (such as the Lenovo ThinkpPad® Advanced Dock (2503-10U). While they are often promoted as capable of supporting 16 lane PCI-E graphics cards, in reality only a single lane of PCI-E is used due to the docking connector lane width restriction (independent of the graphics card lane capabilities). Once again, this limits how much rendering performance gain can be achieved and effectively reduces usage to merely a display port replicator. This scenario isn't as prone to as much of a performance loss as a simple port explicator, due to the local rendering on the add-in card.

Cabled Connections

The advantage of a cabled connection is its use with multiple products potentially from multiple suppliers. It can also give flexibility to the final product form factor and placement – an important point to make when confronted by a typical cluttered desktop.

There have been two primary cabled connections used for external graphics solutions.

A few companies have implemented a high-end laptop solution featuring a single lane cable connected to a PCI-E express card such as the Asus XG Station. This has had the advantage of fitting into current designs. But primarily due to the extremely limited bandwidth and the resulting performance impact (i.e.: limited or no Windows Vista Aero features enabled for most resolutions and long game load times) versus high cost, at the current time no major supplier has commercially shipped any of these designs.

Another recent option comes from the PCI SIG standards organization with the introduction of its PCI-E cable and connector specification. This solution offers combinations from one up to 16 lanes, supporting PCI-E 1.1 speeds. However, the size and the cost of the connectors and cables will likely prevent them from being used on a consumer level platform.

Other Connector Options

One of the advantages to keeping with the PCI-E spec is that graphics drivers are written and optimized specifically for this bus interface. Latencies, burst speed, bi-directional support, buffering and other factors have all been tuned so that the drivers can help optimize graphics performance.

Using a different interface other than for frame buffer and frame transfers (as for some of the port replicators) would be prohibitive in the amount of effort to develop optimized drivers, which would negatively affect the odds of success.

Therefore this discussion has kept focus on what types of connectors are available that can support PCI-E bus signaling.

Table 3 shows some of the previous major contenders for this type of interface. An emphasis for small size (footprint and profile), low cost, PCI-E 2.0 speeds, and manufacturability (connector, cable and board) are all considered when analyzing the options.

Table 3 : PCI-E Connector Options : Current

Type	**Lanes**	**Gen 1/2**	**Footprint mm / mm²**	**Profile mm / mm²**	**Notes** *[2]
PCI-E SIG Ext Cable	4	1*[1]	28.4 x 29.5 209	18.2 x 7.3 135	(internal width = 18.2, Snout width = 24.5) does NOT include shell depth includes housing
PCI-E SIG Ext Cable	8	1*[1]	40.4 x 29.5 1192	40.4 x 7.4 299	(internal width = 30.2) does NOT include shell depth includes housing
PCI-E SIG Ext Cable	16	1*[1]	40.3 x 53.25 2146	40.3 x 11.9 480	Includes shell depth and housing
VHDCI	16	1	42.8 x 19.0 813	42.7 x 12.8 547	Stacked (x2) = 138 pins total SCSI3 type
Samtec VPDPC	8	1, 2	34.6 x ~9.6 332	34.6 x 5.1 176	
Samtec VPDPC	16	1, 2	57.8 x ~9.6 555	57.8 x 5.1 295	
Display Port	2	1	20.4 x 14.8 302	20.4 x 6.1 124	Can't support all of PCI-E Cable spec features

Note 1: Gen 1 as per current spec
Note 2: The connector drawings for the PCI-E SIG External Cable Spec are inconsistent between the

different connector options. Some include the shell, some include the shield, and some don't. Where the shell is included, it is noted. An attempt has been made to reflect the size of the final connector usage, with the single note on the front shell variance.

INTRODUCING ATI EXTERNAL GRAPHICS PLATFORM TECHNOLOGY

After more than two years of research and development, AMD is introducing the first consumer friendly high speed ATI eXternal Graphics Platform (ATI XGP™) total solution. This new technology not only includes a new compact and low cost high performance interconnect solution, but is fully integrated into the ATI Radeon™ graphics driver functionality. This total solution offers enhanced features for a superb user experience and tight integration with other innovative AMD platform and ATI Radeon graphics technologies.

ATI XGP is a full platform technology solution encompassing both the physical interconnect and the software interface and feature integration. The intent is to establish a new interconnect standard while positively impacting the way that consumers buy and use their computers.

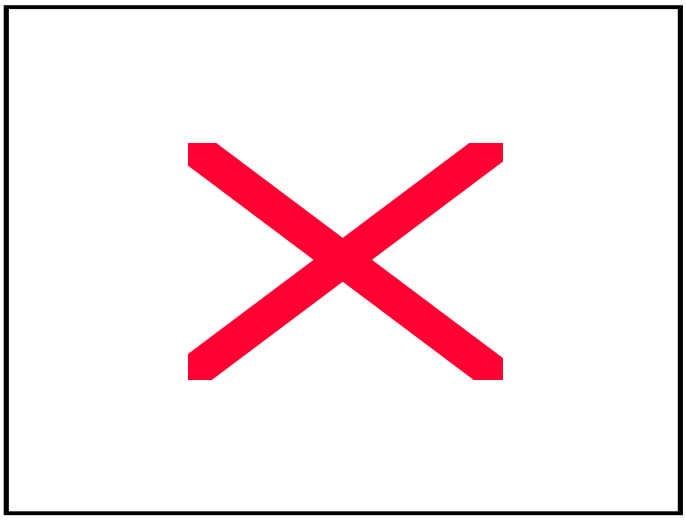

Figure 1 : ATI XGP External Unit

Some of the key highlights of the ATI XGP technology are:

- 8 or 16 lane PCI-E 2.0 connectivity
  - initial product launches support 8 lanes
  - future interconnectivity planned for between 8 and 16 lane devices
  - enough bandwidth to accommodate simple to very high-end ATI XGP platforms
- Low cost solution
  - pricing on the board connectors is set low enough to enable inclusion on most motherboards
  - cabling prices are directly competitive with other consumer high speed cables (but supplying more bandwidth)
- Small footprint and profile
  - allows solution to fit on sub-notebook size motherboards
  - 8 or 16 lane option allows designer to match performance requirements versus space constraints
  - profile fits into compact notebook height constraints
- Minimal support circuitry required
  - supports standard PCI-E cable spec control signaling protocols
  - includes system isolation to avoid issues with separate power supplies between units
  - minimal foot print and components on host system side
    - helps keeps cost and footprint requirements down for easier inclusion
  - minor foot print and circuit requirements for ATI XGP unit
  - easy to implement with any standard PCI-E 2.0 compliant device
- Consumer usage friendly

  - full native PCI-E hot plug under Windows Vista (reboot is not required with certain AMD graphics motherboards)
  - simple latch helps prevent accidental disconnect
  - latch includes minor audible click upon proper insertion for positive user feedback
  - durable and easy to handle connectors : rated for >10,000 insertions
  - symmetrical cable – user can plug either end into host or ATI XGP based box
  - enhanced driver operation adjusted specifically for external graphics
  - future consumer usage features under consideration
  - up to 2 meter cable length to allow for convenient placement of the host or ATI XGP device
- Platform Focused
  - designed to support multiple products from single GPUs to multiple PCI-E devices behind PCI-E bridges
  - includes USB 2.0 link to support a variety of devices including USB 2.0 hubs, hard drives, Blue Ray optical drives, and other USB connected items

Connector/Cable Solution

Although there has been an ongoing desire to develop a method to drive an external graphics device, no consumer friendly option had been available. To be consumer friendly, the board connector must:

- have a compact form factor (limited board space and mobile profile restrictions)
- be low cost
- have sufficient bandwidth for current and planned applications
- not require any special or expensive manufacturing techniques
- be available in sufficient volumes
- offer reliability over large connection counts
- include easy latching mechanism to prevent accidental disconnection

The cable assembly must meet the following requirements:

- reasonable length options
- light and flexible
- reasonable cost
- easy to connect and disconnect
- provide symmetry and other ease of use considerations

Traditionally requirements such as compact size and high bandwidth without special manufacturing techniques have translated into high costs. In addition, if a connector and cable design are not already in mass production at high volumes, economies of scale may not be present and the initial launch costs may be high.

Over the course of six months, AMD conducted research to investigate options by working with major companies capable of developing and shipping high speed connectors. AMD concluded that there weren't any current or known future options that met the requirements. The business/cost model and volume supply capabilities were critical factors in the decision process.

Rather than start from scratch, AMD sought either a current solution or an existing technology as a starting point that could be modified to meet the requirements. As a result, AMD sought a technology partner that could meet all of the product requirements while having the reputation for excellent engineering and design capabilities, as well as being able to meet the required cost/volume business model along with having the proper resources and ability to commit to support the program.

The chosen technology partner was Japan Aviation Electronics Industry, Limited (JAE) -- known for a wide range of connectors and very specifically for high speed, small footprint designs, and consistent quality manufacturing.

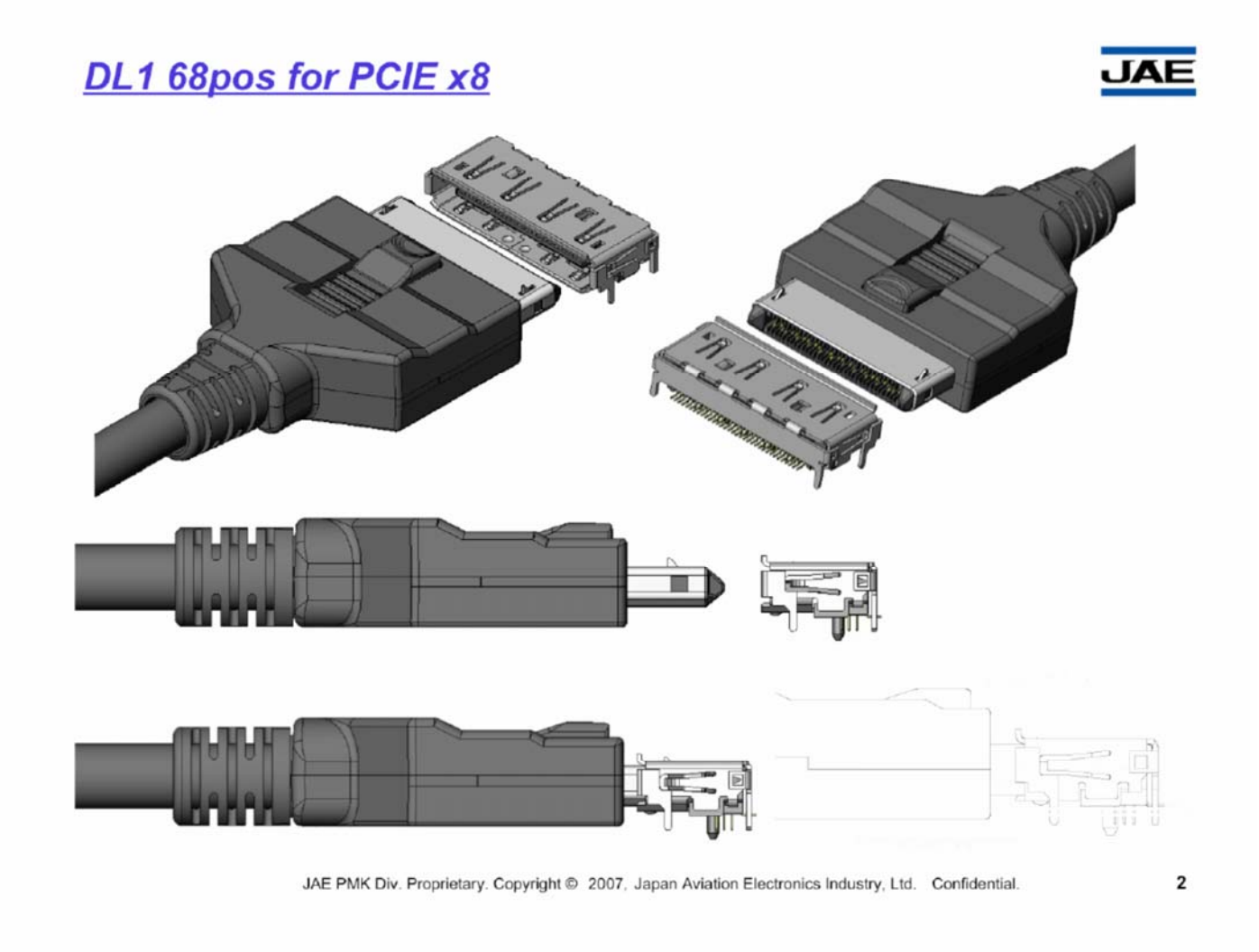

Figure 2 : ATI XGP Connector/Cable Solution

An additional 6-9 months was required to design, simulate and work out the details for the first prototypes. The remaining time of the two year research and development period was used for testing and developing the final hard tooled production version.

The Table 4 shows the footprint/profile square area and bandwidth per area comparison of the ATI XGP solution versus other options. Figure 3 gives a visual comparison of the same. Required space and bandwidth limits give ATI XGP a considerable advantage.

As shown, the ATI XGP connectors not only fit into small notebook vertical profiles but also offer a footprint density to bandwidth advantage. It should be noted that while there are other high density options, they typically either require special and expensive board manufacturing technology or have component costs out of the required range.

Table 4 : Connector Profile and Performance Density

Connector	Lane Count	PCI-E Ver	Profile: area (mm^2)	Footprint: area (mm^2) / performance (Mbytes/sec / mm^2)
ATI XGP	**16**	**2**	**324.8**	**649.6 / 12.3**
ATI XGP	**8**	**2**	**197.3**	**394.67 / 10.1**
PCI-E Sig	16	1.1	479.0	1062.6 / 03.8
PCI-E Sig	8	1.1	311.85	1194.75 / 01.7
VHDCI	16	1.1	547.84	813.2 / 04.9
Display Port	2	1.1	124.44	301.92 / 01.7

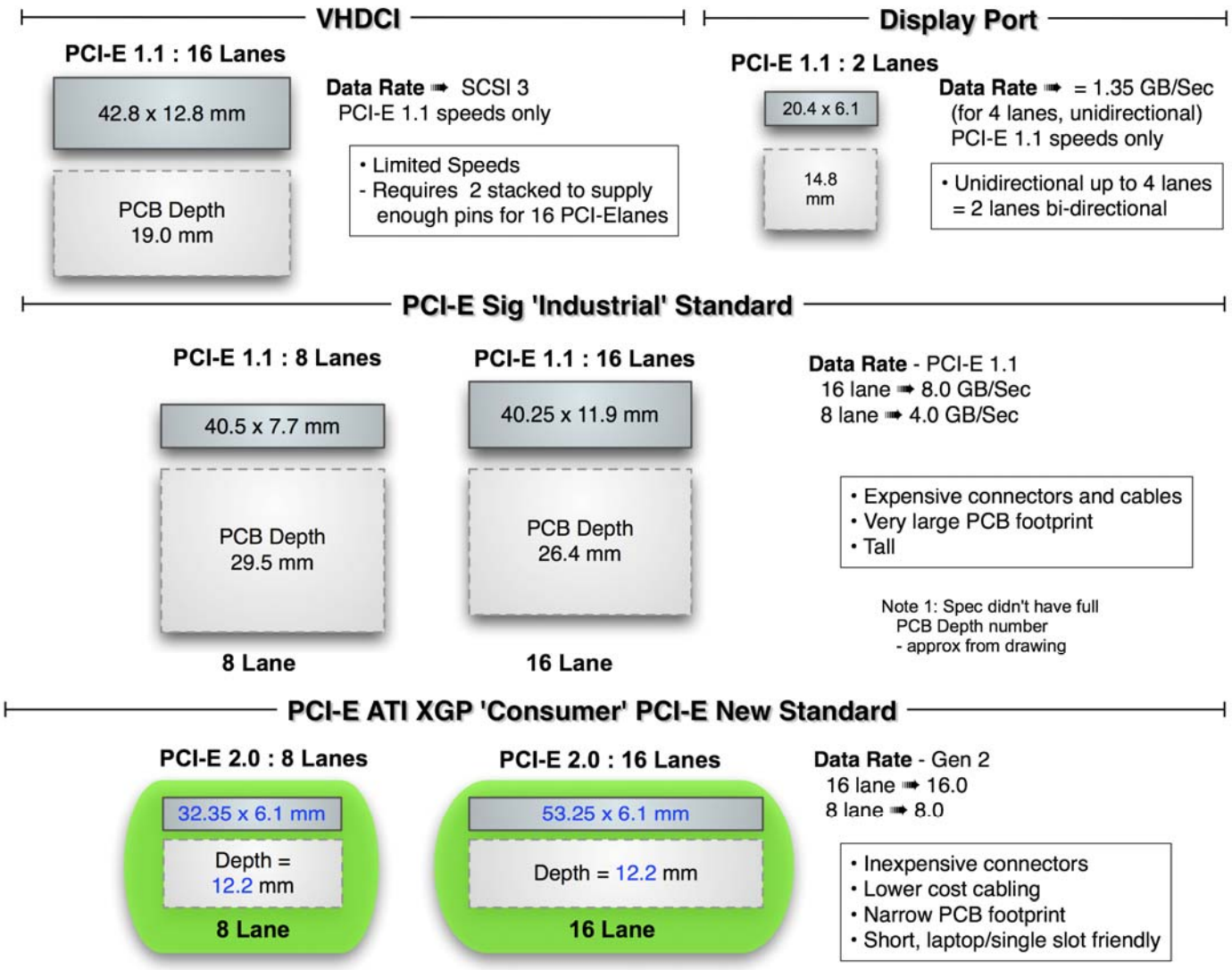

Figure 3 : ATI XGP Connector Size Comparison

User Features and Software Integration

HOT-PLUG

For a laptop that will be truly mobile, one of the most obvious feature requirements is to support true hot-plug capability. The user needs to be able to just plug the ATI XGP device into a system without the hassle or complication of always having to shut the system down and reboot.

ATI XGP technology takes advantage of what is called 'Native PCI-E Hot Plug' which is defined by the PCI-E 2.0 specification. Microsoft Windows Vista has added enhanced native hot-plug support that ties closely to the PCI-E specification. ATI XGP is an early adopter of this technology and has successfully implemented it through system BIOS enhancements, built-in support in the AMD/ATI chipset and GPU families, and driver modifications.

The user simply plugs in an ATI XGP box into their host system which automatically recognizes the box, loads the driver(s) as required, and enables the attached monitors.

To disconnect an ATI XGP box, referring to the Windows Vista implementation, the user selects the 'remove device' icon from the system tray on their screen and selects the ATI XGP device to disconnect. The system quickly cleans up the resources and informs the user that it is safe to remove the device.

In the future, AMD expects to develop the ability to safely remove ATI XGP devices without this extra step.

USER DESKTOP AND DISPLAY USAGE

Figure 4 : Desktop Display Functionality from Laptop - Multiple Displays

One of the more interesting aspects that occurs when connecting an ATI XGP device is that the usage model of the laptop changes. Traditionally the laptop has been treated as something that moves around, with a built-in display plus an option for one external display, The laptop also has the ability to perhaps attach a few external peripherals.

When the user plugs an ATI XGP device into a laptop, the usage of the system can change substantially — the system has the ability to function more like a traditional desktop system. For example, the user can have multiple displays, up to six in some scenarios. Users have the luxury of connecting hard drives, additional USB ports, and other peripherals, all available by connecting a single cable to their laptop.

Display management is a good comparison of how this impacts the user interface. As a single laptop with the ability to support only two monitors, a single hot key to toggle between three different display combinations is ideal. But with ATI XGP, the user now can potentially have three or more displays connected at a time, so a hot key method to control displays doesn't make sense. There is no simple and logical way to map out a single key to go through all the display options.

As an alternative, AMD has taken the logical approach to now consider the laptop plus ATI XGP as a 'standard' desktop configuration. Using the powerful ATI Catalyst™ Control Center (CCC) program, the user has full control over each display connected to their system. In addition, for quicker basic control, the ATI system tray icon allows easy access for the user to directly control each display.

When the ATI XGP device is disconnected, standard laptop type behavior is fully restored.

CROSS DISPLAY

Figure 5 : Cross Display Technology Enables ATI XGP Acceleration on Laptop's Display

Considering the cases where the user wants to carry the ATI XGP unit with them or has a large very high quality display already included in their laptop, ATI will be supporting ATI Cross Display technology on ATI XGP systems. This allows the ATI XGP unit to directly drive the laptop display (plus one external display connected to the laptop if desired), enabling the high performance graphics output right on the laptop without the need of an external monitor connected to the ATI XGP unit itself. This helps to enable a truly portable, high performance capability.

USABILITY ENHANCEMENTS

While the desktop mode can support most of the requirements of an ATI XGP user, there is still room for additional fine tuning.

One of several enhancements is the method for adding a new monitor to the system. For a desktop system when a new card and/or monitor is added, the user needs to configure it as to how they want to use it.

When an ATI XGP box is attached for the first time, it is assumed that the user is planning to use the new monitor as an extended desktop. Based on this assumption, the drivers have been modified to automatically and dynamically enable any monitor attached to an ATI XGP device to turn on as extended monitors whenever the ATI XGP unit is plugged in. The user is ready to start viewing onscreen content without any additional steps. This default monitor usage can altered by way of the ATI Catalyst Control Center.

As an extra aid to the user, the hardware design supports two different indicator lights on the ATI XGP unit to display current status. The first is traditional power indicator. The second light activates after the PCI-E interface has been established to the ATI XGP box and after the initial driver communications has successfully started.

POWER CONTROL

Unlike most traditional external computer devices, there is no power button included for ATI XGP for the simple reason there is no need for one.

The ATI XGP power is directly controlled from the connection to the host system. Assuming that the ATI XGP unit is plugged in, it automatically powers up and down in response to the host and its connection to it.

There is no need for the user to turn on or off the device – it is fully automatic.

Table 5 : ATI XGP Power Control

Case	ATI XGP Power Status
No ATI XGP connection	Off
Host is off	Off
Host is on	On
Host is asleep	Off

When the ATI XGP device is off, depending on the final design of an individual unit, a negligible amount of power is required to observe the connection and host status. In fact, the largest usage of power in the off state is by the AC to DC supply which traditionally always has some amount of power consumption when plugged into the wall.

FURTHER TECHNOLOGY INTEGRATIONS

When using ATI Catalyst Control Center for monitor control, the ATI XGP driver and SBIOS architectures also are designed to integrate other new and future AMD technologies. For example, when an ATI XGP system supports ATI PowerXpress™, the integration and user interface is already configured to be easily accessed through the ATI Catalyst Control Center interface.

This architectural integration extends to a wide variety of planned features and technologies — ATI XGP specific along with ATI Radeon graphics and AMD system based capabilities.

New Paradigm – New Possibilities

NEW USAGE CASES

Until now, consumers and power users had only three purchase options: buy a laptop with limits; buy a powerful desktop; or, if budget allows, buy one of each.

ATI XGP completely changes the playing field for many users, both in personal computing and professional productivity. Here are just a few scenarios that may be enabled with this technology.

Case 1 : Laptop can now function as a full desktop replacement while still remaining a true laptop

- Laptop has ATI XGP connector to allow additional high performance graphics at any time
- A more powerful CPU can be included to support high end graphics
    - CPU runs in low power mode when ATI XGP not attached and running on battery
    - CPU uses some of the power/thermal budget normally reserved for internal graphics when ATI XGP is doing the work
- Maintains lightweight, good battery life but offers full desktop performance when needed
- True performance upgrades now available through ATI XGP
    - More powerful graphics
        - High end GPUs
        - Additional of ATI CrossFireX multi-GPU functionality

  - Additional and new multi-media capabilities
  - Other acceleration processors
  - Other additional peripherals

Case 2 : Family or group of users sharing ATI XGP units for cost saving and convenience

- Family has multiple ATI XGP enabled computers
- ATI XGP units can be purchased as needed and shared between the different users (i.e. each user can use the ATI XGP unit for a period of time)
  - Mix of one or two mid-range units and one or two ultimate gaming/rendering units
- Uses do not have to move from system to system just to get performance
- Convenient and easy to swap ATI XGP units without disrupting work flow

Case 3 : Professional with need for high quality graphics at work and home

- Can have one laptop for work and office with an ATI XGP unit at each location
  - no need to synchronize or transfer data between desktop and laptop machines
- Can have more powerful ATI XGP unit at the office and low cost unit at home if needed
- ATI XGP units can be light enough to travel on business trips to keep up productivity, even when on the road

Case 4 : Office full of PCs with different graphics requirements

- All PCs could have an ATI XGP connector and moderate to low-cost graphics
- As employees or teams need high-end graphics, ATI XGP units can be deployed as needed (i.e. each user can use the ATI XGP unit for a period of time)

NEW DESIGN AND CONFIGURATION OPTIONS

In the desktop and workstation market, to support high-end graphics, systems typically have to be designed for the worst case power, thermal, and physical size requirements. As size or complexity increases, costs can rise as well.

By using ATI XGP technology, the consideration for a high-end graphics processor is effectively removed from the base system design. The base unit can be designed for a low to moderate performance graphics performance and potentially decrease thermal, power, and size requirements for a more manageable and competitive cost range.

Then, depending on the requirements of the end customer, an ATI XGP unit can be chosen specifically for the end user's needs to go with the low cost base unit. This eliminates the need to burden all purchasers of a line of systems with the cost to support a limited number of high-end customers.

Another scenario applies to a high-end graphics workstation. To allow the workstation to be expanded the design either has to include extra slots or a larger power supply. Alternatively, it could include an ATI XGP connector. The result is a high-end performance design and high-end expandability but with managed costs.

ATI XGP is also ideal for allowing ATI XGP partners to differentiate their product lines. The designer has full control over the form factor, the thermals, the feature set, and the industrial look.

Platform in the ATI XGP Name

As mentioned, the decision to support PCI-E was done very carefully. In addition to supporting graphics processors, an ATI XGP unit can also support multiple devices, as long as they interface to the PCI-E or USB buses. The use of the term "Platform" is intentional.

Potential ATI XGP scenarios could include the following, where the end user can add additional PCI-E and USB-based components:

- Set-top graphics accelerator and HDMI Enabler with Blu-ray Optical Drive
- Tethered docking station for graphics acceleration with hard drive, USB peripherals, network connections
- Physics and other accelerators
- Game console upgrades/expansions

POTENTIAL ATI XGP PLATFORM CONFIGURATIONS

There are many different options for an ATI XGP unit. To help show a few examples, two block diagrams are shown here (Figure 6). The first is a low cost, simpler concept with a single GPU and an USB hub. The AC-DC power supply can either be internal to the design or it can use external power.

The second diagram illustrates a higher end ATI XGP unit consisting of two high performance GPUs supported by a 48 lane PCI-E switch and includes a USB hub plus a USB hard drive.

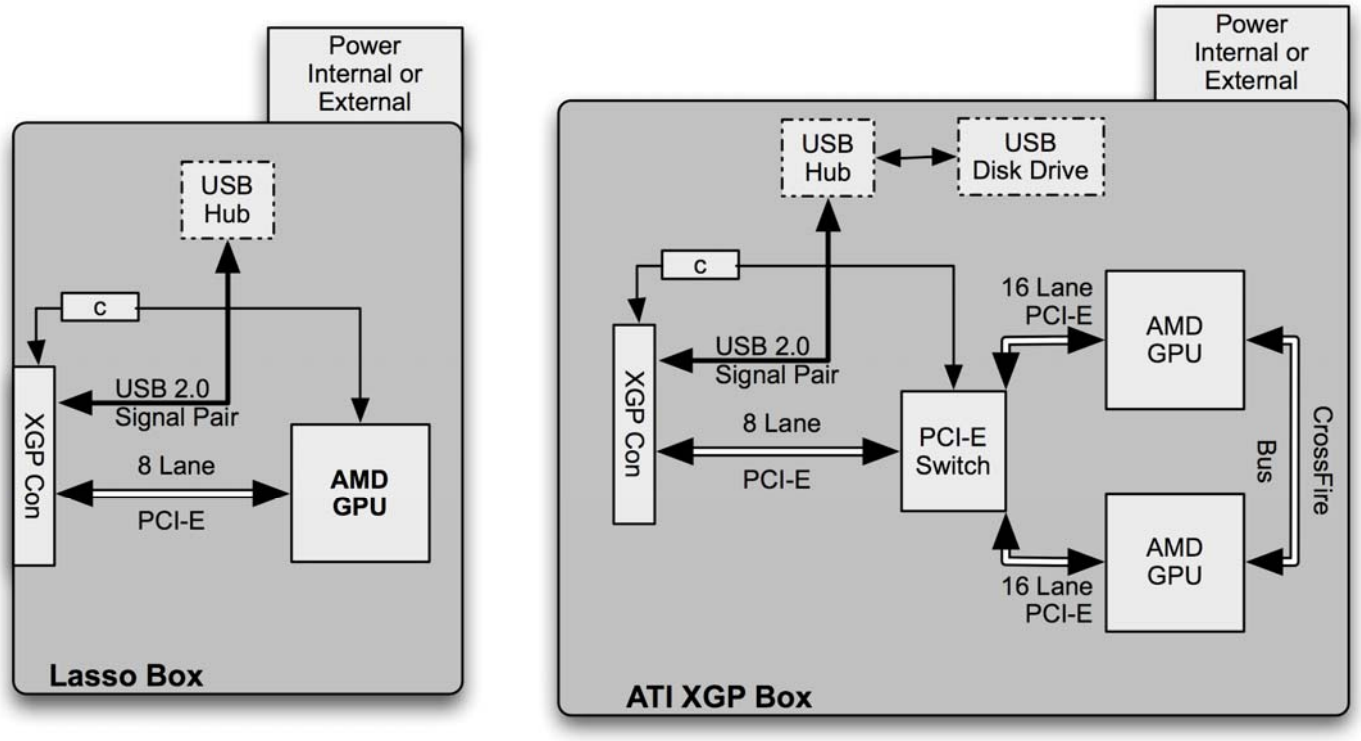

Figure 6 : Two ATI XGP Block Diagrams; Low Cost (left) and High Performance (Right)

ATI XGP HOST SYSTEMS OPTIONS

The ATI XGP connector can be mounted directly onto the motherboard of any host system that can supply 8 or more lanes of PCI-E 2.0 compliant signals. The two block diagrams in Figure 7 show an IGP graphics system on the left and a discrete graphics based system on the right.

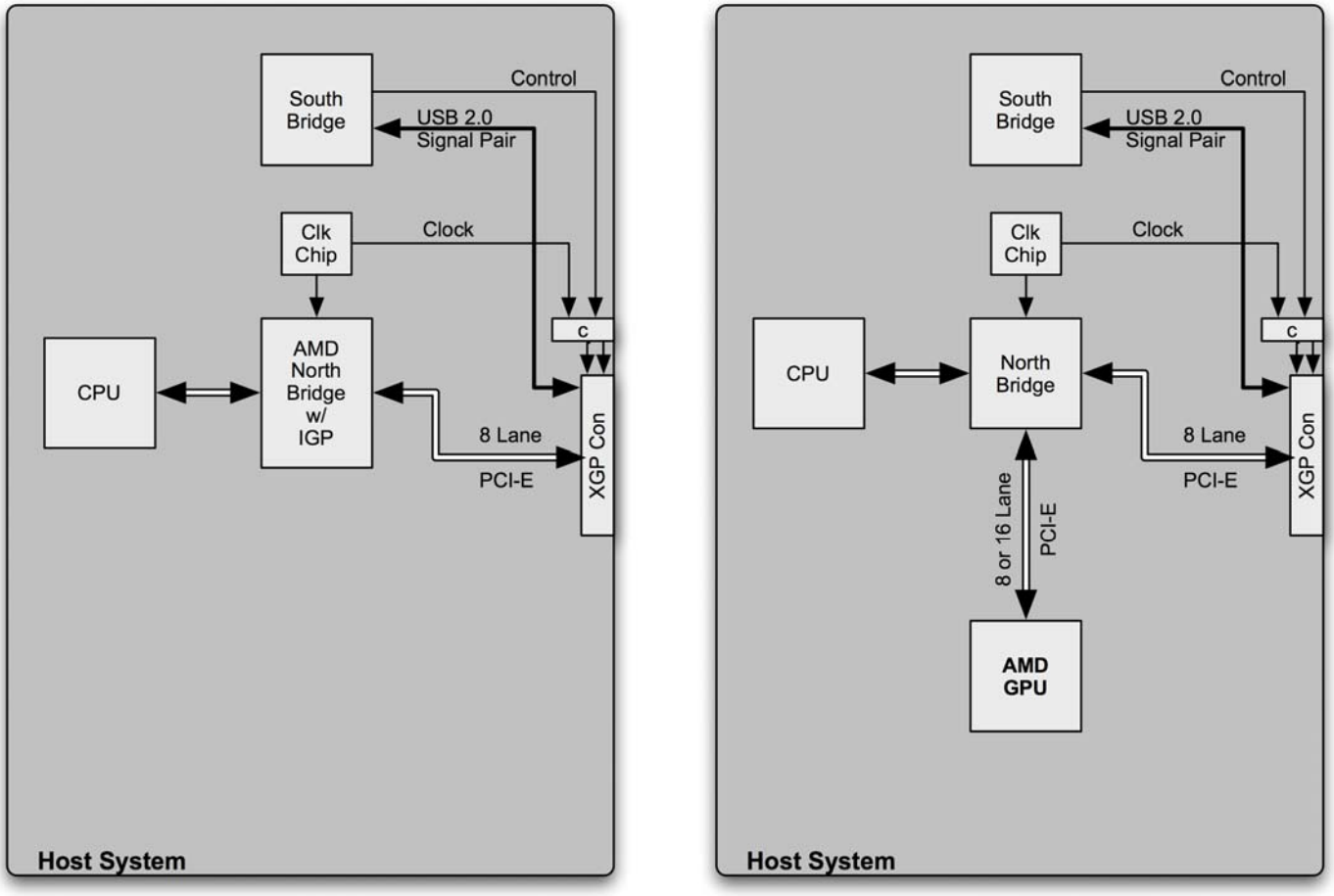

Figure 7 : Host ATI XGP System Block Diagrams

SUMMARY

ATI XGP technology is the combination of many different innovative technologies to create one complete solution. This melding of different technologies is designed to enable the computer and home entertainment industries to offer the widest differentiation of products.

With ATI XGP, performance, form factor, size limits and many other design constraints are no longer the restrictive issues they've been in the past.

The result is a vast range of new possibilities and usage models for both developers and users.

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