IT@Intel White Paper

Intel IT
Processor Graphics
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Processor Graphics Systems Provide Significant Business Value

Processor graphics systems—with their superior stability, power and cost efficiency, and support for emerging technologies and use cases—have become an important part of Intel IT's transformation of the IT ecosystem for the applications and devices of the future.

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Executive Overview

Processor graphics systems—with their superior stability, power and cost efficiency, and support for emerging technologies and use cases—have become an important part of Intel IT's transformation of the IT ecosystem for the applications and devices of the future. The architectural improvements available with 4th generation Intel® Core™ processors, which yield significant performance improvements over previous generations of processor graphics technology, have accelerated our adoption of processor graphics systems. Whereas two years ago 20 percent of our workforce required discrete graphics, that number has dwindled to about 5 percent.

Processor graphics (graphics processing capability built into the CPU) provide enterprise benefits in four areas:

- **Stability.** We have found that processor graphics systems incur the "blue screen of death" at a dramatically lower rate than systems with discrete graphics.
- **Power efficiency.** Discrete graphics systems weigh more and run hotter than processor graphics systems, which means more fan noise, power consumption, and weight due to the cooling solutions required. In our tests, processor graphics systems draw less power and have a longer battery life than discrete graphics systems.
- **Cost effectiveness.** Because they do not require a separate, expensive discrete graphics card or graphics processing unit, processor graphics systems cost less to provision and are less complex to support. Processor graphics systems also improve and support efficient driver management by enabling IT to use a single unified driver across all platforms.
- **Support for emerging technologies and use cases.** Key enterprise technologies such as Keyboard-Video-Mouse Remote Control and Intel® Pro Wireless Display work only with processor graphics. In addition, because of their high performance and lighter, cooler platform, processor graphics systems are a natural fit with our mobile, collaborative workforce and can support emerging interaction methods, such as touch and perceptual computing.

Processor graphics systems also support our efforts to embrace the consumerization of IT, because these systems meet the consumer demands our end users have, such as capabilities for video and limited gaming. The combination of these benefits make processor graphics systems an important part of our IT ecosystem strategy.

Contents

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BACKGROUND

Previously, both desktop and laptop PCs at Intel used discrete graphics to accommodate high-end graphics applications. Desktop PCs had a dedicated graphics card; laptops had a graphics processing unit (GPU).[1] Both the card and GPU, which were separate from the CPU, represented an additional cost item when configuring the PC.

Over the last few years, early processor graphics systems, which have the graphics-processing capability built into the CPU, began to displace discrete graphics systems at Intel. Currently, Intel IT has transitioned our standard platforms almost completely from discrete graphics systems to processor graphics systems that use Intel® Core™ processors and Intel® Atom™ processors.

The numerous architectural improvements available with 4th generation Intel® Core™ processors yield significant performance improvements over previous generations of the technology (see the sidebar, A Deeper Look at the Latest Generation of Processor Graphics on Intel® Core™ Processors). Only about 5 percent of our workforce still requires discrete graphics compared to 20 percent two years ago. In our experience, processor graphics provide significant business value compared to discrete graphics. In fact, we are no longer purchasing discrete graphics systems for the general office environment or standard platforms because the performance of processor graphics systems meets the majority of our standard business needs.[2] In addition, these systems support the ongoing consumerization of IT—which we embrace—because the performance also meets end users' consumer demands for capabilities such as video and gaming.

[1] In this paper, the discussion applies equally to desktop and laptop PCs; however, because Intel's workforce is highly mobile, we are primarily interested in the mobile benefits of processor graphics, and most of our research relates to the mobile computing environment.

ENTERPRISE BENEFITS OF PROCESSOR GRAPHICS SYSTEMS

Based on our evaluation, we've found that processor graphics systems provide enterprise benefits in four areas:

- Stability
- Power efficiency (and resulting improved user experience)
- Cost effectiveness
- Support for emerging technologies and use cases

In our experience, processor graphics systems are as good as or better than discrete graphics systems for most use cases. For example, processor graphics systems support the ability to project high-resolution graphics to multiple monitors (up to three at once). Based on the benefits summarized in Figure 1, we've increased the percentage of processor graphics systems in use at Intel. We no longer purchase discrete graphics systems except on a case-by-case basis, and we are eliminating them from our standard PC fleet through our refresh cycle.

[2] Discrete graphics systems are still required by some engineers using specific applications.

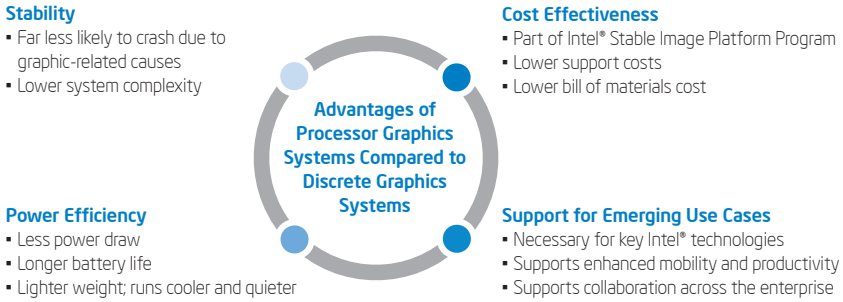

Figure 1. Processor graphics provide benefits in four primary areas: stability, power efficiency, cost effectiveness, and support for emerging use cases.

Stability

As shown in Figure 2, Intel IT defect data indicates that the blue screen of death (BSOD) rate for discrete graphics systems is significantly higher than for processor graphics systems (six times more likely to experience a BSOD).

By reducing the number of blue screen and software incidents associated with discrete graphics, we reduce our support costs in the following ways:

- Defects such as blue screens typically recur until either the employee or Intel IT's Proactive Client Health team intervenes. BSODs have a significant impact on employee productivity; each time, the employee cannot use the PC or laptop until the issue is resolved or the system is rebooted, and data is sometimes lost from that computing session.
- Eighty percent of Intel employees are highly mobile and often do not have access to a local IT department. When discrete components fail, the employee must seek resolution in a PC service center—resulting in further disruption to employee productivity.

Processor graphics systems, by their nature, eliminate the need for separate graphics cards and GPUs—and their associated device drivers. By reducing the total number of device drivers, we reduce fleet complexity and increase system reliability. Processor graphics are part of the Intel® Stable Image Platform Program (Intel® SIPP); therefore, we can rely on a predictable transition from one technology generation to the next as platform updates occur, and we can use a single unified driver across all processor graphics systems. In addition, Intel SIPP helps prevent compatibility issues that sometimes occur between applications and device drivers.

Power Efficiency

Processor graphics systems consume significantly less power than discrete graphics systems, resulting in less energy consumption, longer battery life, and less heat generated from the laptop. The more heat a system generates, the faster the system wears out and is likely to incur heat-related BSOD and system failure.

With discrete graphics systems, the cooling systems and power supplies add additional weight to the overall platform, limiting portability and mobility. Also, the additional fans necessary on discrete graphics systems generate significantly more noise than a cooler-running processor graphics system.

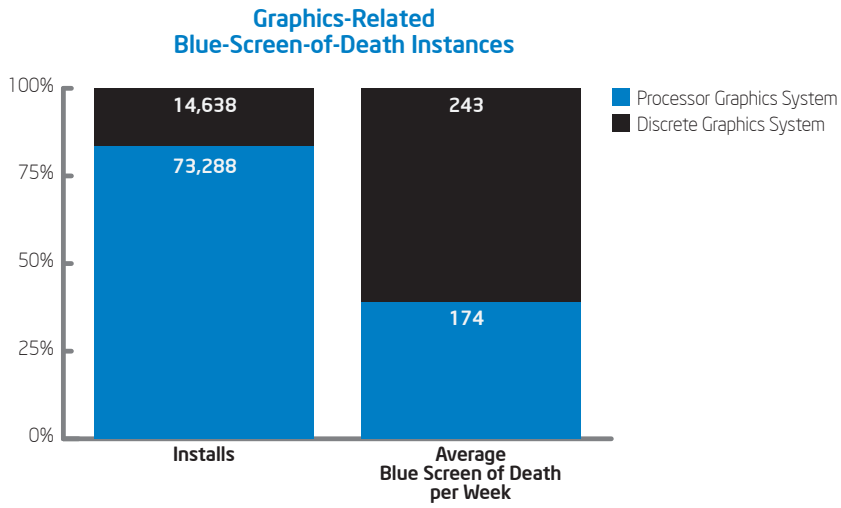

Figure 2. At Intel, the blue screen of death rate for discrete graphics systems is significantly higher than for processor graphics systems.

A Deeper Look at the Latest Generation of Processor Graphics on Intel® Core™ Processors

The 4th generation Intel® Core™ processor graphics benefit from Intel® Turbo Boost Technology 2.0. The 4th gen Intel Core processor also provides a number of architectural improvements[1] over the 3rd gen Intel® Core™ processor, speeding up processing several ways:

- A 2x increase in geometry pipeline throughput
- A 4x increase in speed for sampling with comparison
- A 2x increase in speed for sampling with offset
- An increase in speed for memory bandwidth-intensive operations due to large on-chip, last-level eDRAM cache (available with Intel® Iris™ Pro graphics 5200)

Several tools are available that can help developers optimize their graphics, such as the Intel® Graphics Performance Analyzers and Intel® VTune™ Amplifier XE.

[1] For more details, see http://download-software.intel.com/sites/default/files/4th_Generation_Core_Graphics_Developers_Guide_Final.pdf.

As shown in Table 1, when compared to a processor graphics system, a discrete graphics system consumes up to 22W more during the business benchmark test, about 17W more during OS setup, and about 10W more at idle. Because processor graphics systems consume less wattage, their battery life is 22 to 31 percent longer than a discrete graphics system, depending on the GPU mode.

Cost Effectiveness

We have found that processor graphics systems—both client PCs and data center servers—are more cost effective, compared to discrete graphics systems.

CLIENT PC COST BENEFITS

Because processor graphics are part of the Intel SIPP, the resulting consistency of components and device drivers across the whole fleet lowers support costs. Also, many vendors offer discrete graphics only with higher performing CPUs, increasing the overall cost of systems that include discrete graphics. Processor graphics are already a component of the Intel® architecture in use at Intel; therefore they do not represent an additional cost. Generally, a discrete graphics platform adds 5 to 10 percent additional cost to the platform, depending on the configuration.

DATA CENTER SERVER COST BENEFITS

Intel has a highly virtualized computing environment, especially for our silicon chip design compute loads. For virtualized solutions, applications render the graphics on the client PC unless it doesn't have the capability, in which case the application offloads graphics rendering to the server, and the rendered image is then sent to the client over the network.

In general, processor graphics on client PCs have sufficient RAM and graphics processing ability to project high-resolution graphics to multiple monitors (up to three at once), the same as a discrete graphics processing system. However, on occasion, the graphics rendering is offloaded to the servers. Prior to the availability of high-performance processor graphics, we equipped servers with costly discrete cards. These cards were not only expensive to purchase, but also expensive to use, increasing power and cooling costs. Equipping servers with processor graphics eliminates those extra costs and the power load.

Support for Emerging Technologies and Use Cases

A processor graphics system supports key Intel IT initiatives and goals, such as supporting a high level of employee mobility, adopting new technologies that reduce costs and provide enhanced enterprise capabilities, and improving collaboration across the enterprise.

INCREASING MOBILITY AND PRODUCTIVITY

Intel's workforce is highly mobile. Therefore, we value technologies that increase productivity while employees are on the go. Discrete graphics systems require a platform that—compared to a processor graphics system—is larger, heavier, hotter, and louder, with a shorter battery life. This can negatively affect employees' ability to accomplish their tasks. For example, with discrete graphics, a field representative might have to use a full-size laptop and have to recharge the battery every few hours. Processor graphics enable that employee to use a smaller, lighter, cooler, and quieter business Ultrabook™ device, which can run significantly longer between charges.

KEY ENTERPRISE TECHNOLOGIES

Certain key enterprise technologies work only with processor graphics. Examples include Keyboard-Video-Mouse (KVM) Remote Control and Intel® Pro Wireless Display (Intel® Pro WiDi). In addition, because of their high performance, processor graphics systems are a natural fit with emerging interaction methods, such as touch and perceptual computing.

- **KVM Remote Control,** a hardware-based feature of PCs with 2nd generation Intel® Core™ vPro™ processors and later and Intel® HD Graphics, significantly reduces the time Intel IT Service Desk technicians spend solving some of the common PC issues Intel employees face every day, thereby reducing support cost and improving employee productivity. Service Desk technicians can use hardware-based KVM Remote Control to diagnose and repair PCs even if the OS is nonfunctional.
- **Intel Pro WiDi**[3] supports seamless sharing of high-resolution graphics within a broad ecosystem of projectors, displays, and adapters. Beyond the interoperability afforded by the Miracast* standard,[4] Intel Pro WiDi adds performance, quality, and

[3] For more information on Intel® Pro Wireless Display, see "Evaluating Intel® Pro Wireless Display for Enterprise Use."

[4] Miracast* is a popular and widely available open standard for delivery of audio and video across devices.

Table 1. Comparison of the Power Efficiency of Discrete and Processor Graphics Systems. Intel internal measurements, February 2013

	Discrete Graphics System	Processor Graphics System
Power Supply Requirement	▪ 90W	▪ 45W to 65W
Power Consumption	▪ 68.2W during a business benchmark test ▪ 73.6W during OS setup ▪ 34.5W at idle	▪ 52.1W during a business benchmark test ▪ 56.6W during OS setup ▪ 24.1W at idle
Battery Life	▪ 258 minutes in switched mode ▪ 211 minutes in locked mode	▪ 277 minutes

reliability, resulting in a premium display sharing solution that meets enterprise requirements for manageability, privacy, and security.

- Future applications may use cutting-edge interaction methods, such as eye scrolling, visual emotion detection, and voice intonation detection, in addition to other features, such as augmented reality and anticipatory computing.[5] Increasing the availability of processor graphics at Intel is part of our effort to transform the IT ecosystem to support the applications and devices of the future.

COLLABORATION ACROSS THE ENTERPRISE

Intel is a large global company, with over 90,000 employees in 164 sites, spread across 63 countries. The majority of our employees work on virtual teams, collaborating with team members at a variety of locations. To support our culture of collaboration and ensure the free flow of information, we are always looking for new ways to enable our employees to be more productive and increase job satisfaction. Processor graphics systems support this goal by supporting graphics-intensive collaboration methods, such as 3D videoconferencing and the sharing of videos through the Intel Video Portal—an especially important capability as video becomes more and more vital to the enterprise. Processor graphics systems will allow employees to take advantage of additional innovative ways to collaborate, such as through webcasting and virtual events.

[5] Intel employees will be able to choose which input methods best suit their particular situations and control which input methods they use. Applications will adhere to corporate guidelines about various input methods, to enable personal privacy at all times.

CONCLUSION

Compared to discrete graphics, processor graphics offer increased system stability, better power efficiency, better cost effectiveness, and support for emerging technologies and use cases. Also, the many architectural improvements available with 4th gen Intel Core processors yield significant performance improvements over previous generations of the technology. Because we embrace the consumerization of IT, we also value the ability of processor graphics systems to support consumer use cases, such as video and gaming. The combination of these benefits makes processor graphics systems an important part of IT ecosystem strategy—we no longer purchase discrete graphics systems except on a case-by-case basis and are eliminating them from our standard PC fleet through our refresh cycle.

Our defect data indicates that processor graphics systems are far less likely to suffer from BSOD issues compared to discrete graphics systems. Also our tests show that, compared to discrete graphics systems, processor graphics systems draw less power, have a longer battery life, and provide a better user experience because they run cooler and more quietly, and weigh less. Perhaps even more importantly, processor graphics support our goal of transforming the IT ecosystem to support the applications and devices of the future. For example, key enterprise technologies such as KVM Remote Control and Intel Pro WiDi—which both offer significant enterprise benefits—work only with processor graphics. Because of their high performance and lighter, cooler platform, processor graphics systems are a natural fit with our highly mobile and collaborative workforce.

For more information on Intel IT best practices, visit www.intel.com/it.

ACRONYMS

BSOD	blue screen of death
GPU	graphics processing unit
KVM	Keyboard-Video-Mouse