ANALYSIS OF INTEL INTEGRATED GRAPHICS OF THE 11TH GENERATION

Romanyuk Alexander,
Doctor of Technical Sciences,
Professor, Head of the Department of Software Engineering,
Vinnytsia National Technical University

Artem Marushchak,
student,
Vinnytsia National Technical University

Shmaliukh Vladyslav
student,
Vinnytsia National Technical University

Integrated decay processors (GPU) are widely used to improve image quality, to form the realism of the graphic image today. The leading companies that produce this type of graphics include AMD and INTEL. Although CPU performance quickly peaked, GPU development poential has only begun to gain momentum, as shown in Figure 1[1].

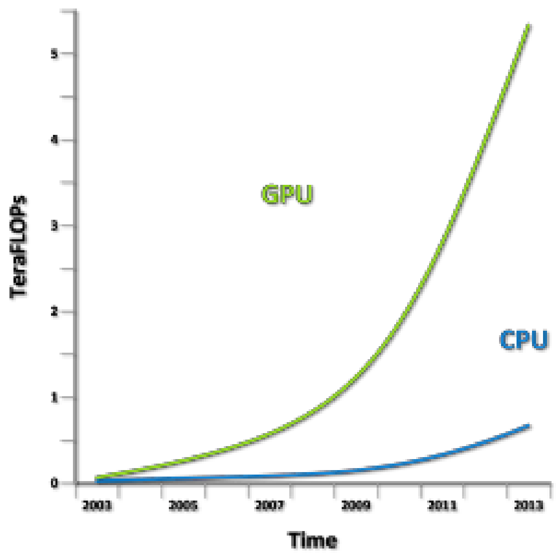

Figure 1. GPU and CPU performance development

All modern video cards are divided into integrated and discrete. The advantage of the former is the low level of power consumption and small size, which allows you to place the GPU on the same chipset with the CPU[2-3]. Discretes, in turn, is characterized by high performance and are placed in the form of a separate unit or chip on the motherboard. The development of technology encourages users to systematically improve the performance of their device, but owners of mobile platforms do not have this opportunity. Therefore, leading companies intend to raise the performance standards of low-power built-in video cards.

Intel has been slowly but surely working on its GPU initiative and one of the first fruits of its labour, the Gen 11 graphics. Featuring 1.12 TFLOPs of power[5], new GPU featured in Ice Lake processors are the first Intel GPU can compete against NVIDIA's MX and AMD's Vega lineup of power-efficient mobility GPUs.

Gen11 is based on 64 units of execution (EUs), which increases the basic computing power by 167% over Gen9[5]. Innovations improve bandwidth by compressing, increasing L3 cache, and increasing peak memory bandwidth.

The rasterizer has been enhanced and features 16 pixels per clock. It is capable of processing 32 bilinear filtered texels per clock and has 3MB of dedicated L3 cache with 0.5 MB of shared local memory per raster[4]. Overall, the architecture has been optimized and is much wider while the need for power efficiency has not been compromised. Ice Lake's Gen 11 graphics is also the first Intel graphics to support the open VESA Adaptive-Sync standard.

Apart from this, some new standards have been added to the architecture including hardware-level support for HEVC decoding all the way up to 8K Ultra HD and 10-bit colour[5]. This means HDR 10 and Dolby Vision are fully supported and ongoing support for VP9 is retained. Last but not least, there is a newly updated Intel Graphics control panel which improves the overall user experience of Intel's graphics side.

Intel's processors are complex SoCs integrating multiple CPU cores, Intel Gen11 processor graphics and additional fixed functions all on a single shared silicon die. The architecture implements multiple unique clock domains, which have been partitioned as a per-CPU core clock domain, a processor graphics clock domain, and a ring interconnect clock domain. The SoC architecture is designed[2-4] to be extensible for a range of products and enable efficient wire routing between components within the SoC as shown in Figure 2[4, p.6].

The graphics of the Gen11 processors are based on Intel's 10-nm process, using third-generation FinFET technology. Analysis and restructuring of the entire microarchitecture were performed to provide a significant performance improvement per unit capacity. Gen11 supports all major APIs[4] DirectX 12, OpenGL, Vulkan, OpenCL and Metal.

The foundational building block of Gen11 architecture is the execution unit, commonly abbreviated as EU. The architecture of an EU is a combination of simultaneous multi-threading (SMT) and fine-grained interleaved multi-threading (IMT). These EUs have computed processors that drive multiple issues, single instruction, multiple data arithmetic logic units (SIMD ALUs) pipelined across multiple threads, for high-throughput floating-point and integer compute. The fine-grain threaded nature of the EU's ensures continuous streams of ready to execute instructions, while also enabling latency hiding of longer operations such as memory scatter/gather,

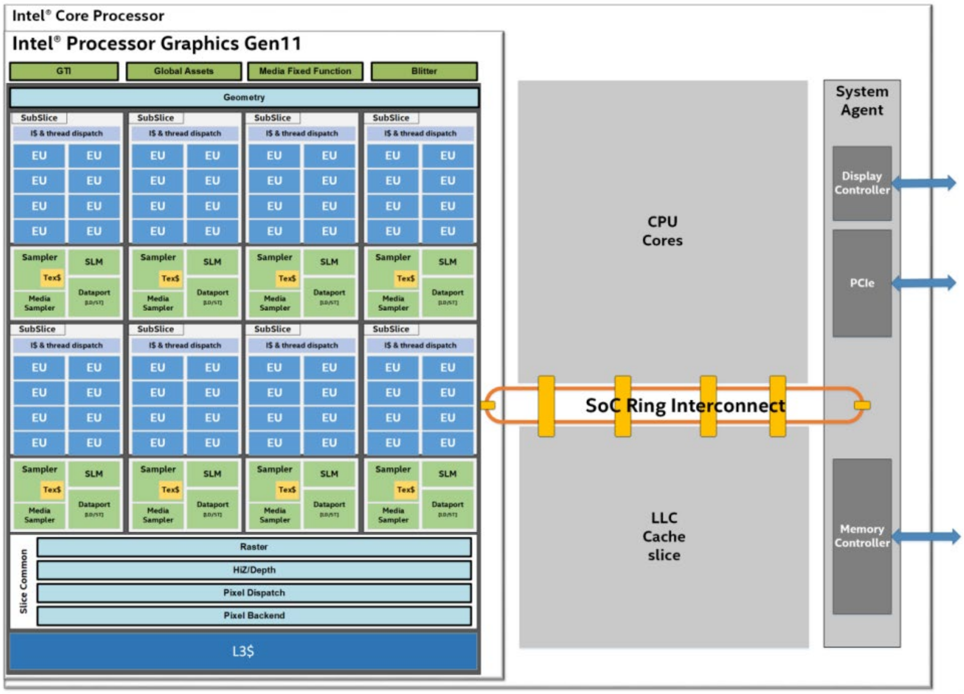

Figure 2. Gen11 detailed block diagram

sampler requests, or other system communication. Depending on the software workload, the hardware threads within an EU may all be executing the same compute kernel code, or each EU thread could be executing code from a completely different compute kernel[5].

In each EU, the primary computation units are a pair of SIMD floating-point units (ALUs). Although called ALUs, they support both floating-point and integer computation. These units can execute up to four 32-bit floating-point (or integer) operations, or up to eight 16-bit floating-point operations. Each EU is multi-threaded to enable latency hiding for long sampler or memory operations. Associated with each EU is 28 KB register file (GRF) with 32 bytes/register. As depicted in Figure 3[4, p.13], one of the ALUs support 16-bit and 32-bit integer operations and the other

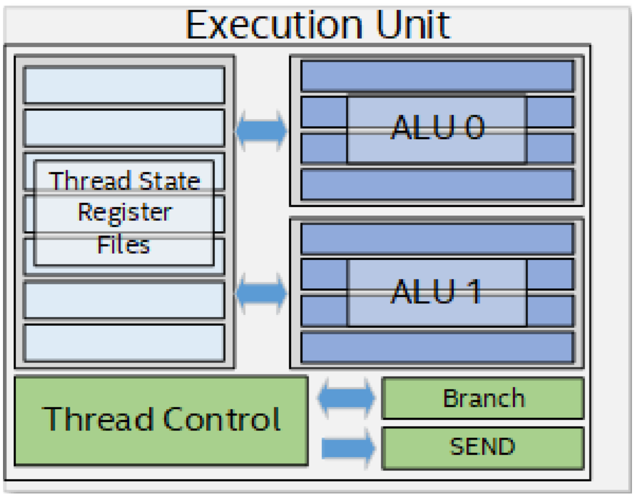

Figure 3. The Execution Unit (EU)

ALUs provides extended math capability to support high-throughput transcendental math functions.

Intel Iris Plus Graphics G7 (Ice Lake with 64 EU)[6] is an 11th generation video card integrated into the Ice Lake SoC (10thx 10GxG7 core), designed for laptops. Another difference is the TDP, as it can be adjusted from 12 to 25 watts in U-models with a power of 15 watts. At this level of performance, this card can compete with the average statistical discrete video cards, as shown in Figure 4[7].

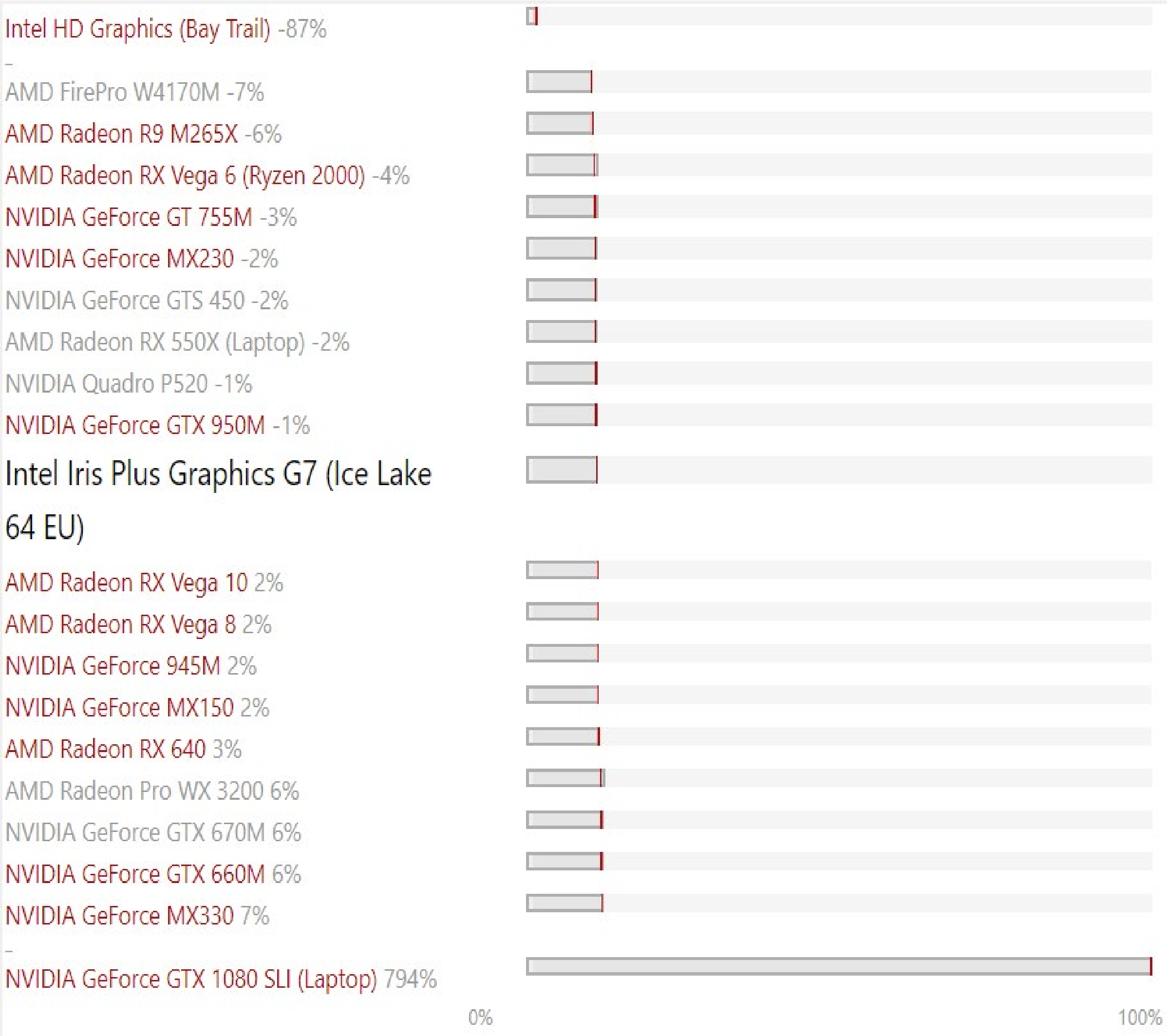

Figure 4. Video card table compared to Intel Iris Plus Graphics G7

So, Intel's new technical solution has led to significant improvements in performance by changing the processing method and architecture. Improving the performance of the graphics core has led to increased productivity, but increased the level of overall power consumption. The 11th generation has an increase of 67% compared to the previous generation. Thus, the GPU generation can compete with the discrete versions of the guilty companies AMD and Nvidia.

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