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ANALYSIS OF INTEGRATED BUILT-IN GRAPHICS PROCESSORS
АНАЛІЗ ІНТЕГРОВАНИХ ВБУДОВАНИХ ГРАФІЧНИХ ПРОЦЕСОРІВ

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Abstract. *The paper analyzes the existing built-in graphics processors in central processors. The work of various types of embedded graphics processors in technological processes is considered.*
Keywords: *control system, architecture, classification, memory, graphics core, shader.*

Introduction.

Built-in graphics processors [1] (integrated graphics processing unit, iGPU) have become one of the key components of modern technological progress. Their importance is constantly growing due to constant changes in the IT environment and the need to effectively achieve the desired results in projects. The transition from conventional GPU [2] (graphics processing unit) to improved processors using new technologies should be especially noted. Various requirements may be placed on the parameters of the graphics processor. The first is the speed of the graphics processor (GPU Clock Speed). This is determined by the number of clock pulses that the processor can execute in one second. The speed of the graphics processor affects its overall performance, the ability to process graphics tasks and the speed of image output.

The second is the number of stream processors (CUDA Cores, Stream Processors, or other similar terms). This is the number of individual computing units that can work in parallel. More stream processors allow the GPU to efficiently handle multitasking and graphics computing. Depending on the requirements of applications and games, a GPU with more stream processors may be required.

Built-in graphics processors are important factors in the modern life of any technology. They are changing user needs, becoming increasingly integrated into systems that help effectively manage aspects of achieving goals.

Analysis of functionality, architecture and classification

The processor's integrated graphics are a key component of modern microprocessors, enabling graphics tasks to be performed without the need for an additional graphics processing unit (GPU). The main functions of embedded graphics are the display of graphics on the screen, shader processing, animation, and graphics-related calculations.

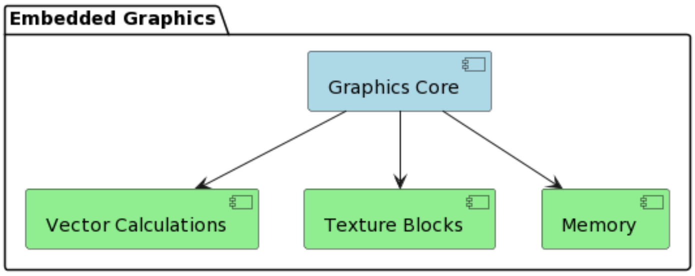

Figure 1 – Integrated graphics processor

The architecture of embedded graphics [3] includes a graphics core, vector calculations, texture blocks and memory necessary for processing graphic data. The graphics core is responsible for rendering and displaying graphics, capable of using a variety of shaders to create complex visual effects. Vector computing provides support for computing vector operations useful for graphics algorithms and image processing.

Embedded graphics processors use a special type of memory known as video memory or VRAM (Video RAM). VRAM is used to store graphics data such as textures, video frames, and other graphics resources. The type and amount of video memory may differ depending on the specific model and manufacturer of the integrated graphics processor. Some integrated GPUs may share memory with main system memory (known as shared memory), while others may have their own video memory. Using dedicated video memory can provide better performance in graphics tasks, as it is dedicated to graphics only and does not compete with main system memory for resources.

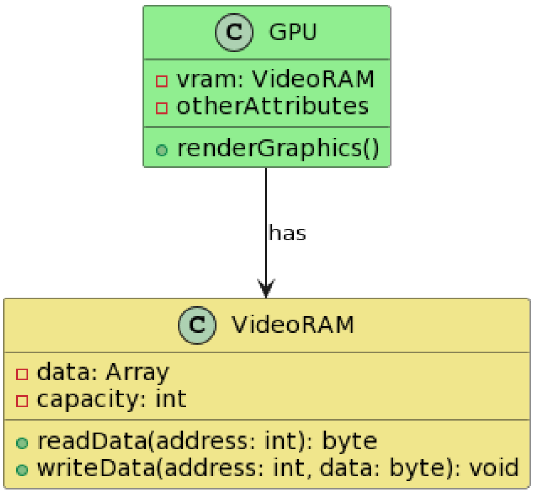

Figure 2 - The architecture of the processor's integrated graphics

The diagram illustrates the main components of an embedded graphics architecture, indicating the relationships between the graphics core, vector computation, texture blocks, and memory. Each component performs specific functions necessary for the efficient execution of graphics tasks.

Graphics processors embedded in central processing units (CPUs) can be classified [4] according to several parameters. First of all, they can be divided into integrated and on-chip (SoC) graphics solutions, and separated from the CPU. Integrated GPUs are often used in laptops and some desktop systems, providing a basic level of performance for a variety of tasks.

The second aspect of the classification consists in distinguishing by the level of performance and purpose. GPUs for embedded use can range from simple ones that meet the demands of everyday tasks, to high-performance ones aimed at gamers or professional users that require high-level graphics processing.

Also, GPUs can be classified by architecture, such as the use of integrated or discrete memories, or by the presence of certain technologies, such as support for ray tracing or artificial intelligence technology to optimize graphics calculations. The classification of integrated graphics processors in processors is important for choosing the optimal solution depending on the needs of the user and the specific use.

Let's consider examples of built-in graphics processors, their characteristics, frequency, which technology they support and what they provide when their work is reproduced.

The Intel UHD Graphics 630 [5] is an integrated graphics processor often used in the 8th and 9th generation Intel Core series processors. This GPU has a base clock frequency of 350 MHz to 1.1 GHz and supports DirectX 12 and OpenGL 4.5. It can display high-quality graphics on the screen, as well as perform basic graphics tasks.

The AMD Radeon Vega 8 [6] is a graphics processor built into some AMD Ryzen 2000 and 3000 series processors. It has an octa-core architecture with a frequency of 1100 MHz to 1300 MHz. Radeon Vega 8 supports technologies such as AMD FreeSync, DirectX 12 and Vulkan, which ensure high performance when playing video and graphics tasks.

The NVIDIA GeForce GT 1030 [7] is an integrated graphics processor from NVIDIA aimed at the budget computer market. It has 384 CUDA cores and a base clock frequency of around 1227 MHz. The GT 1030 is equipped with 2 GB of GDDR5 memory and supports technologies such as NVIDIA GPU Boost 3.0 and DirectX 12. This GPU is well suited for simple games and video processing on a limited budget.

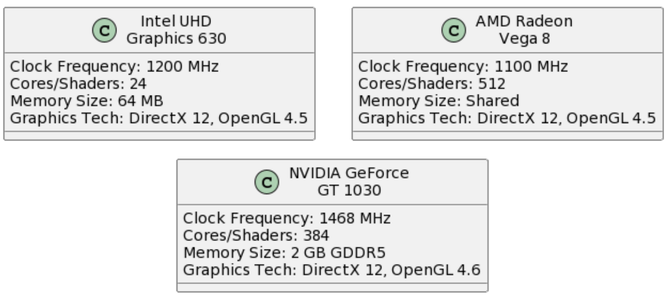

Figure 3 - Comparison of three integrated graphics processors

The chart provides a comparative overview of the characteristics of the three integrated graphics processors. Main parameters include clock frequency, number of cores/shaders, amount of memory and support for graphics technologies.

Integrated graphics in processors is usually represented by a graphics processing unit (GPU), which is on the same chip as the central processing unit (CPU). It is responsible for processing graphics and displaying visual information on the monitor. Some well-known components of integrated graphics chips include:

Graphics Core: This is the main part of the graphics processor, which is responsible for processing graphics operations. In the case of Intel Iris Xe Graphics, this core has integrated computing units, texture units and other components for processing graphics data.

Video RAM (Video RAM - VRAM): Integrated graphics can have its own video memory or use part of the system RAM to store graphics data.

Texture Unit: It is responsible for processing textures and applying them to 3D models to improve graphics.

Shaders: These are software components used to calculate lighting, shadows, color, and other graphical effects. Shaders play an important role in creating realistic graphics. Output Module: Responsible for outputting graphic information to a monitor or other visual device.

Regarding Intel Iris Xe Graphics, this is a family of integrated graphics solutions from Intel. They are used in many processors, including the 11th generation Intel Core. These graphics solutions provide support for modern graphics APIs such as DirectX 12 and Vulkan and provide improved performance compared to previous versions of integrated graphics chips from Intel.

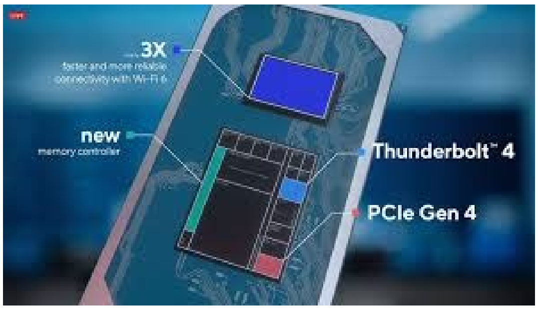

Figure 4 – Intel Iris Xe Graphics chip architecture

In addition to the technical specifications mentioned earlier, it's essential to highlight the role of integrated graphics in everyday computing tasks. Integrated graphics are particularly suitable for general use, including web browsing, office applications, and multimedia consumption. While they may not match the performance of dedicated graphics cards, they offer a cost-effective solution for users who don't require intensive graphical capabilities, such as gamers or professional graphic designers.

Moreover, advancements in integrated graphics technology have led to increased power efficiency and reduced heat generation. This is particularly advantageous for laptops and ultrabooks [9], where thermal management is crucial for maintaining performance and ensuring a longer lifespan of the device. The integration of graphics processing directly into the CPU also contributes to a more compact and energy-efficient overall system design.

It's worth noting that the landscape of integrated graphics is dynamic, with regular updates and improvements. As technology evolves, manufacturers continually refine their integrated graphics solutions to keep pace with the demands of modern applications and ensure a smoother user experience. This ongoing development underscores the significance of integrated graphics in providing accessible and competent graphical performance for a broad range of computing needs.

Embedded graphics [10] processors are presented in the Intel Iris Xe Graphics family with the integration of video memory, texture blocks, shaders and many other components, embedded graphics processors become a powerful tool for creating impressive visual effects. The development of such technologies helps to improve the quality of graphics in various areas, and improvements in speed and performance allow users to enjoy more immersive visual experiences.

Conclusion.

Thus, built-in graphics processors have become one of the key components of effectively achieving the desired results in projects. The detailed functionality and architecture of integrated graphics processors led to a comparative analysis of three specific models: Intel UHD Graphics 630, AMD Radeon Vega 8 and NVIDIA GeForce GT 1030.

These graphics processors are from different manufacturers and are used in different classes of computers. Intel UHD Graphics 630 is used in Intel Core processors for basic graphics tasks. AMD Radeon Vega 8, built into some AMD Ryzen processors, offers decent performance for graphics and video tasks on an average budget. The NVIDIA GeForce GT 1030, although built-in, is in the higher price range and is aimed at budget gaming PCs.

The landscape of integrated graphics processors is diverse, catering to a wide range of users with varying needs and budget constraints. The comparative analysis of Intel UHD Graphics 630, AMD Radeon Vega 8, and NVIDIA GeForce GT 1030 reveals the nuanced differences among these components, from their targeted applications to their technical specifications.

As technology continues to advance, integrated graphics processors have evolved beyond basic display functions, becoming integral to the seamless execution of projects and everyday computing tasks. The tailored use of these GPUs in different classes of computers underscores their versatility, from basic graphics processing in Intel Core processors to the budget-friendly graphics and video capabilities offered by AMD's Radeon Vega 8, and the higher-tier performance suitable for budget gaming PCs with NVIDIA's GeForce GT 1030.

The importance of the comparative table lies in empowering users to make informed decisions based on their specific requirements and financial considerations. Clock frequency, core/shader count, memory capacity, and support for graphics technologies are pivotal factors that users should consider when selecting an integrated GPU. Ultimately, the diverse options available in the realm of integrated graphics processors play a pivotal role in meeting the ever-expanding demands of users, contributing significantly to the overall user experience in the realm of computing.

The comparison table highlights the main characteristics, such as clock frequency, number of cores/shaders, amount of memory and support for graphics technologies. These features are important when choosing a GPU based on user needs and budget.

In general, integrated graphics processors play an important role in providing graphics display on computers, and their choice depends on the specific needs of the user.

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Анотація. *У роботі проаналізовано існуючі вбудовані графічні процесори у центральні процесори. Розглянуто роботи різного типу вбудованих графічних процесорів..*

Ключові слова: *система керування, архітектура, класифікація, пам'ять, графічне ядро, шейдер.*

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