V. Mobile Devices Hardware: GPUs

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1. Graphics processors

- The GPU takes over all the graphics calculations and transformations so that the CPU, which is responsible for many things, does not have to deal with them.
- In mobile devices, the graphics processing unit (GPU) is located near the processor. Since the GPU is inside the chipset, it is physically impossible to find the GPU when looking at the motherboard.
- In computers, the GPU can be built into the CPU or standalone: in the latter case, we usually call it a "video card".

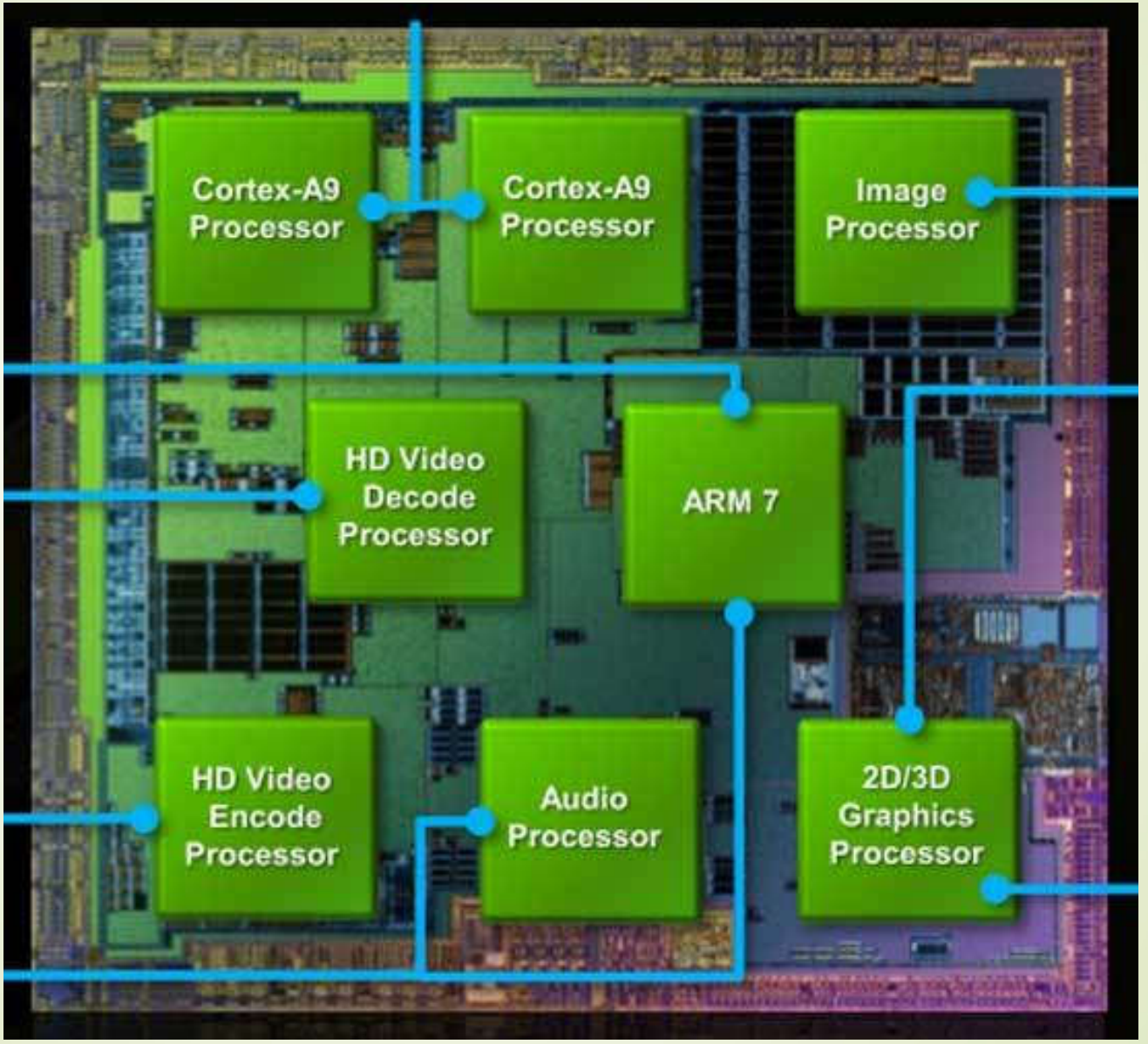
1. Graphics processors

- The reason that the two components in smartphones and tablets are combined into one chipset is that there is not enough free internal space in these mobile devices, and bundling them frees up space for a larger battery.
- Second, packaging the two components as one reduces heat release and saves energy.
- Another reason is that it reduces manufacturing costs because one chip is produced instead of two.

1. Graphics processors

- In practice, smartphones and tablets could handle tasks using only a central processing unit. But then they would look completely different.
- Smooth playback of web pages, fast animations, "live" wallpapers and lightning-fast games are due not only to the central, but to a large extent to the graphics processor.
- All of the graphics features and capabilities of modern mobile devices are largely driven by the GPU.

NVIDIA Tegra 2



2. Capabilities of graphics processors

2D and 3D acceleration

- A GPU must handle: 2D and 3D.
- The calculation of such images is usually called by its English name "rendering".
- Most applications use 2D images, and today even the cheapest GPU does almost as well at rendering 2D content as high-end CPUs.

2. Capabilities of graphics processors

2D and 3D acceleration

- The difference is much more obvious when it comes to processing 3D images, which are typical of video games or design and engineering applications. If the user intends to do exactly this, then he should make sure that he has a good and powerful GPU.

2. Capabilities of graphics processors

Video decoding with graphics acceleration

- Modern graphics processors support so-called "hardware acceleration" when decoding video.
- This means that part of the process of decoding a video (for the purpose of playing it) is transferred from the CPU to the GPU.
- Today, most GPUs handle some of the decoding of even HD video.

2. Capabilities of graphics processors

HD video recording

- Only up until about ten years ago, the average consumer had almost no way to shoot videos themselves, unless they acquired an expensive video camera. Today, in addition to being able to decode (that is, play) HD video, most smartphones and tablets can also record it.
- Achieving HD video resolution (which means 720p or 1080p) is possible thanks to the combined work of the graphics processor, the mobile device's camera and the software that manages the recording and playback of HD content.

2. Capabilities of graphics processors

HD video recording

- The market doesn't pay too much attention to HD anymore, because this standard has already been established everywhere.
- In mobile circles, the talk is more about 4K UHD – a resolution four times higher than HD, which will soon become a main feature in smartphones.

2. Capabilities of graphics processors

Multimedia formats

- Every smartphone or tablet supports multimedia formats, which, simply put, combine different types of media into one, be it text and pictures, sound and video, and so on.
- The support and reproduction of multimedia formats is also one of the many duties of the GPU.

2. Capabilities of graphics processors

Multimedia formats

- The most popular multimedia format currently is MPEG-4, which is used to compress audio and visual data.
- Other popular formats that most smartphones and tablets support today are video formats H.263, H.264 and 3GP and audio formats MP3, FLAC, AMR and MIDI.
- Thanks to their powerful graphics processors, most tablets and smartphones support numerous e-book formats, most of which combine text with graphics.

3. Use of graphics processors

- GPU usage depends on two factors: the architecture of the SoC and the operating system used by the device.
- If the SoC does not have a dedicated media decoding chip, then the GPU should be used to process high definition video.
- It is also possible to offload some tasks to the GPU so that the more powerful and power-hungry processor cores are turned off.

3. Use of graphics processors

- In terms of the operating system, things are much more complicated.
- First and foremost, the GPU is used entirely for all 3D rendering in games and applications. Cortex CPU cores are not designed for this type of task and in all operating systems the GPU is used to perform rendering more efficiently.
- The CPU assists with certain calculations while rendering 3D models on the screen (especially in games), but the main work is done by the graphics chip.

3. Use of graphics processors

- Most graphics cores also support 2D rendering for certain tasks: interface animation and image scaling.
- The CPU usually intercepts these tasks as well, so whether the GPU is used depends on the operating system.

3. Use of graphics processors

Windows Phone OS

- Windows Phone (WP) is animation-heavy, and with the relatively weak SoCs used in WP devices, it's impossible to get smooth animation just by using the CPU.
- In this case, the GPU does much of the work of rendering the main interface and other animation-heavy user interfaces.

3. Use of graphics processors

Android OS

- With Android devices, the situation is different. Low-end devices don't have a powerful GPU and can't offload all 2D rendering to it.
- Google have decided that for compatibility reasons it's better to have all rendering done by the CPU.
- This shortcoming was corrected only with the advent of Android 4.0, since modern SoCs have very powerful GPUs and can render the interface elements.

3. Use of graphics processors

Apple iOS

- Apple iOS on iPhone and iPad have a very smooth and smoothly animated interface thanks to their GPU rendering.

4. GPU manufacturers

Qualcomm Adreno GPUs

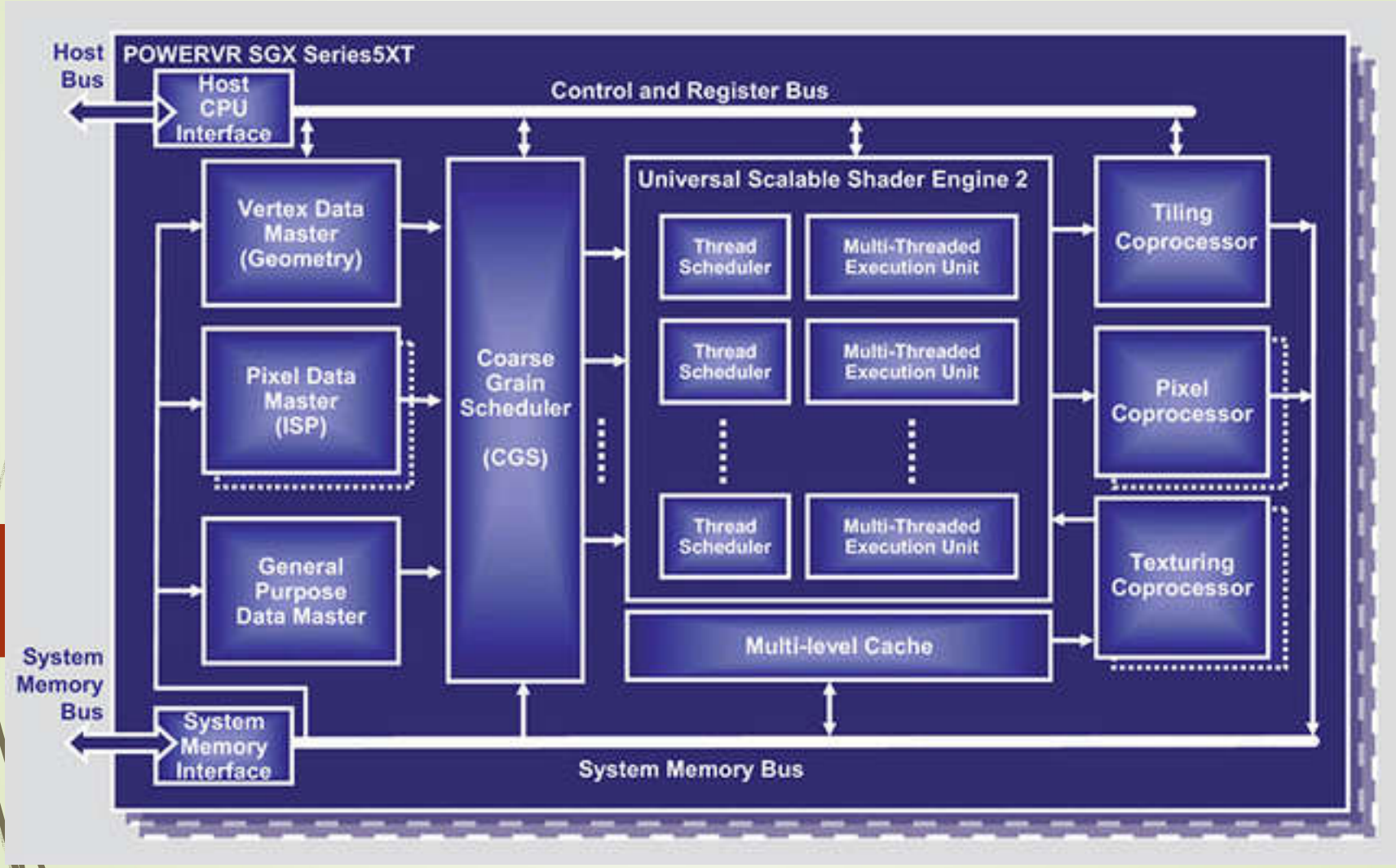
- Aderno GPU is a proprietary graphics chipset used by Qualcomm SoCs. Originally, when it was manufactured by ATI (before Qualcomm bought them from AMD) it was called Imageon.

4. GPU manufacturers

Imagination Tech PowerVR GPUs

- The second major manufacturer of graphics chipsets for smartphones is Imagination Technologies, who make the PowerVR series of mobile GPUs. There are many series of PowerVR GPUs, with modern devices using PowerVR SGX 5 or 5XT series GPUs.
- PowerVR GPUs have been licensed to other SoC manufacturers and thus can be found in many devices. TI OMAP chipsets exclusively use PowerVR GPUs. They can also be found in the old Samsung Exynos chipsets, as well as in the Apple A4 and A5 chipsets. They are also sometimes used with Intel x86 processors in low-end laptop computers.

PowerVR SGX 5XT



4. GPU manufacturers

ARM Mali GPUs

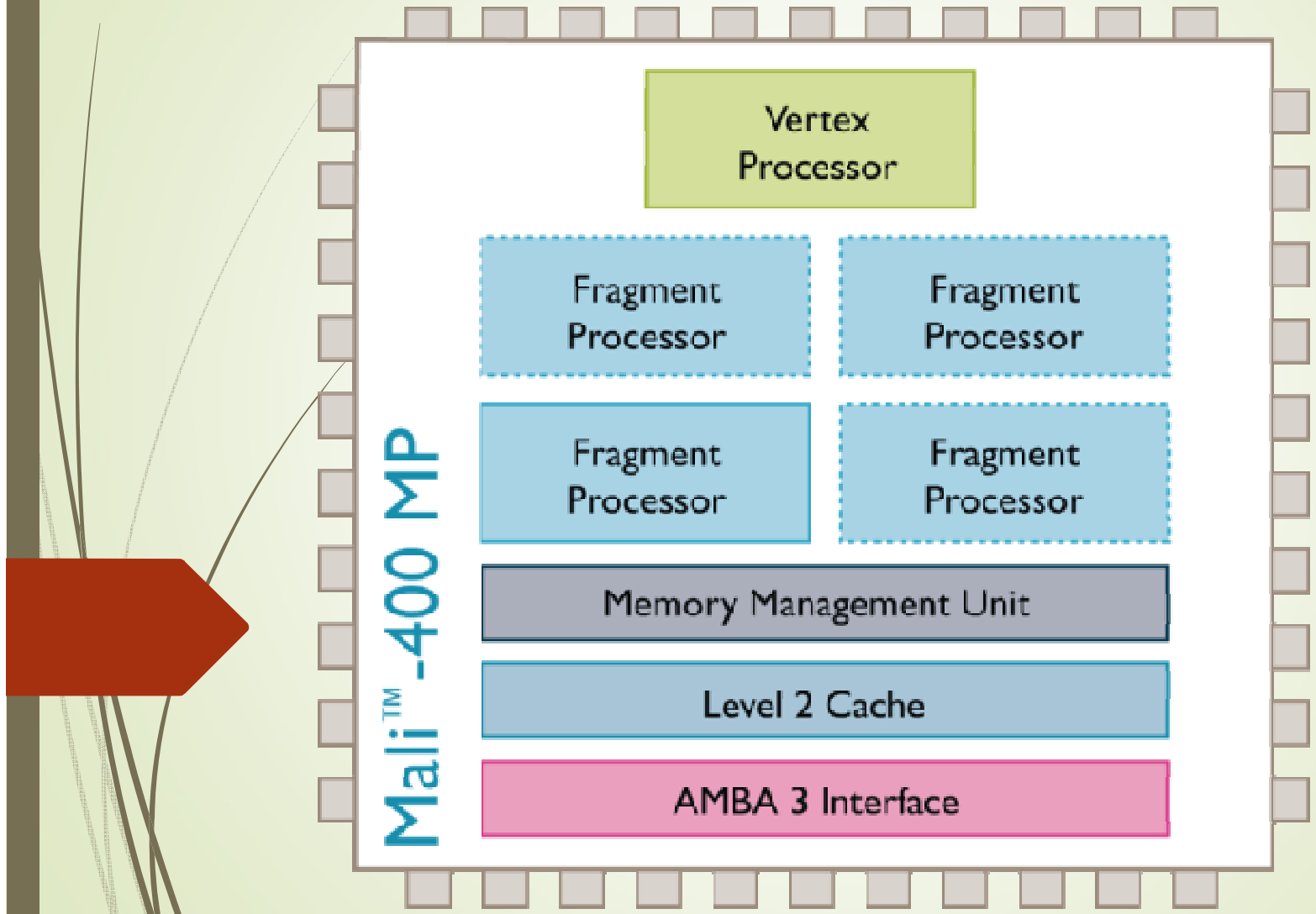
- One of the most important GPUs is the ARM Mali.
- The Mali™-450 MP processor, for example, supports up to eight cores and combines high performance with low power consumption.
- Energy saving is provided by technology that allows the video processor to reuse a maximum part of the available resources during graphics work.

4. GPU manufacturers

ARM Mali GPUs

- Mali-400 MP is another popular ARM graphics model. This processor provides both 2D and 3D acceleration, supports resolution up to 1080p and, at the same time, also saves energy.
- The Mali-400 MP processor only supports up to four cores. But CPU core count remains more important than GPU core count.
- Experts only pay attention to how many cores a GPU has when comparing it to another model based on the same architecture.

GPU ARM Mali-400 MP4



GPU ARM Mali- T604

4. GPU manufacturers

NVIDIA ULP GeForce GPUs

- GeForce GPU that is used in their chipset Tegra is the slowest GPU of the first generation of dual-core processors. ULP GeForce is used in two main Tegra 2 chipsets: Tegra 250 AP20H and Tegra 250 T20.
- The Kal -El GeForce GPU used in the Tegra 3 has weaker performance than the Mali-400 MP4 and PowerVR SGX543MP2.

Comparison of some GPUs

Графичен процесор	SoC	Устройство	GFLOPS при 200 MHz	GFLOPS в SoC
PowerVR SGX543MP4+	PSVita	PlayStation Vita	25.6	25.6+
PowerVR SGX543MP2	Apple A5	Apple iPhone 4S	12.8	16 при 250 MHz
Mali-400 MP4	Exynos 4210	Samsung Galaxy S II	7.2	9.9 при 275 MHz
"Kal-El" GeForce	Tegra 3	ASUS Transformer Prime	4.8	9.6 при 400 MHz
PowerVR SGX540	OMAP4460	Galaxy Nexus	3.2	6.1 при 384 MHz
Adreno 220	MSM8260	HTC Sensation	N/A	N/A
ULP GeForce	Tegra 2	Motorola Xoom	3.2	5.3 при 333 MHz
PowerVR SGX540	OMAP4430	Motorola Droid Razr	3.2	4.8 при 304 MHz
ULP GeForce	Tegra 2	LG Optimus 2X	3.2	4.8 при 300 MHz
PowerVR SGX540	Hummingbird	Samsung Galaxy S	3.2	3.2 при 200 MHz
Adreno 205	MSM8255	HTC Titan	N/A	N/A
PowerVR SGX535	Apple A4	iPhone 4	1.6	1.6 при 200 MHz
PowerVR SGX530	OMAP3630	Motorola Droid X	1.6	1.6 при 200 MHz
Adreno 200	QSD8250	HTC HD7	N/A	N/A