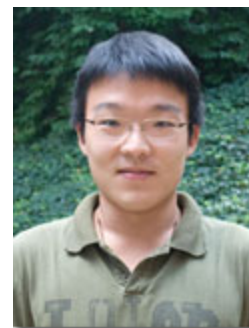


Liang Wang



Runjie Zhang

Introduction

- What: SoC for Mobile Devices
- When: Q1 2010
- Where:



LG Optimus Pad

[LEARN MORE](#)



Samsung Galaxy Tab 10.1

[LEARN MORE](#)



Acer Iconia Tab A500

[LEARN MORE](#)



Toshiba Tablet

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ASUS Eee Pad Slider

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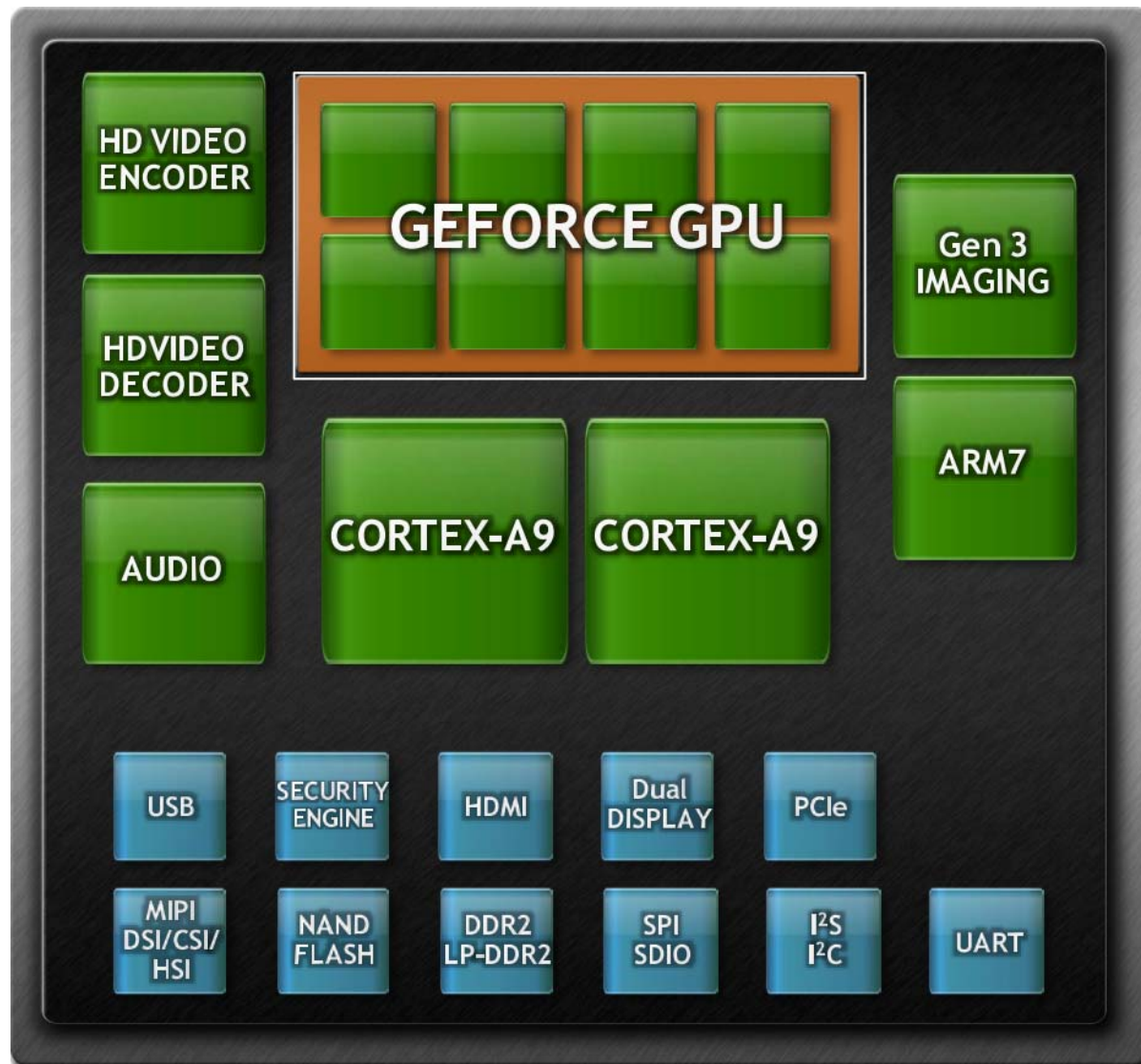
ASUS Eee Pad Transformer

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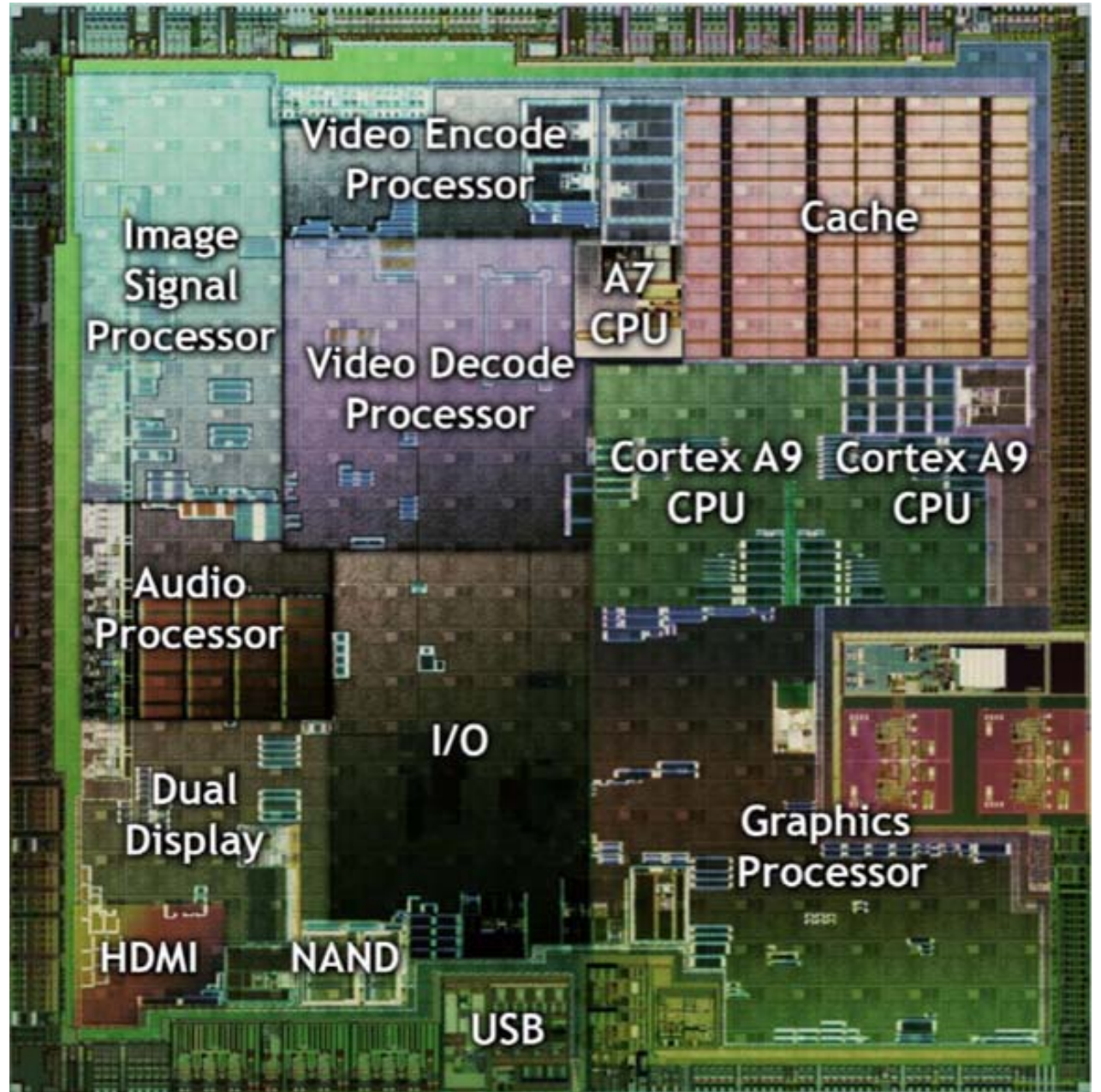
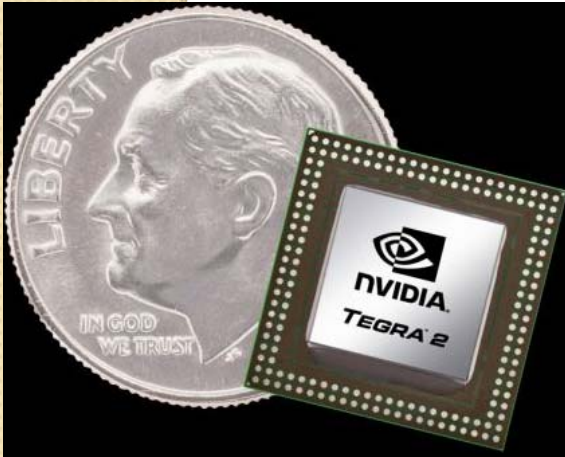
Source: NVIDIA

Architecture Overview



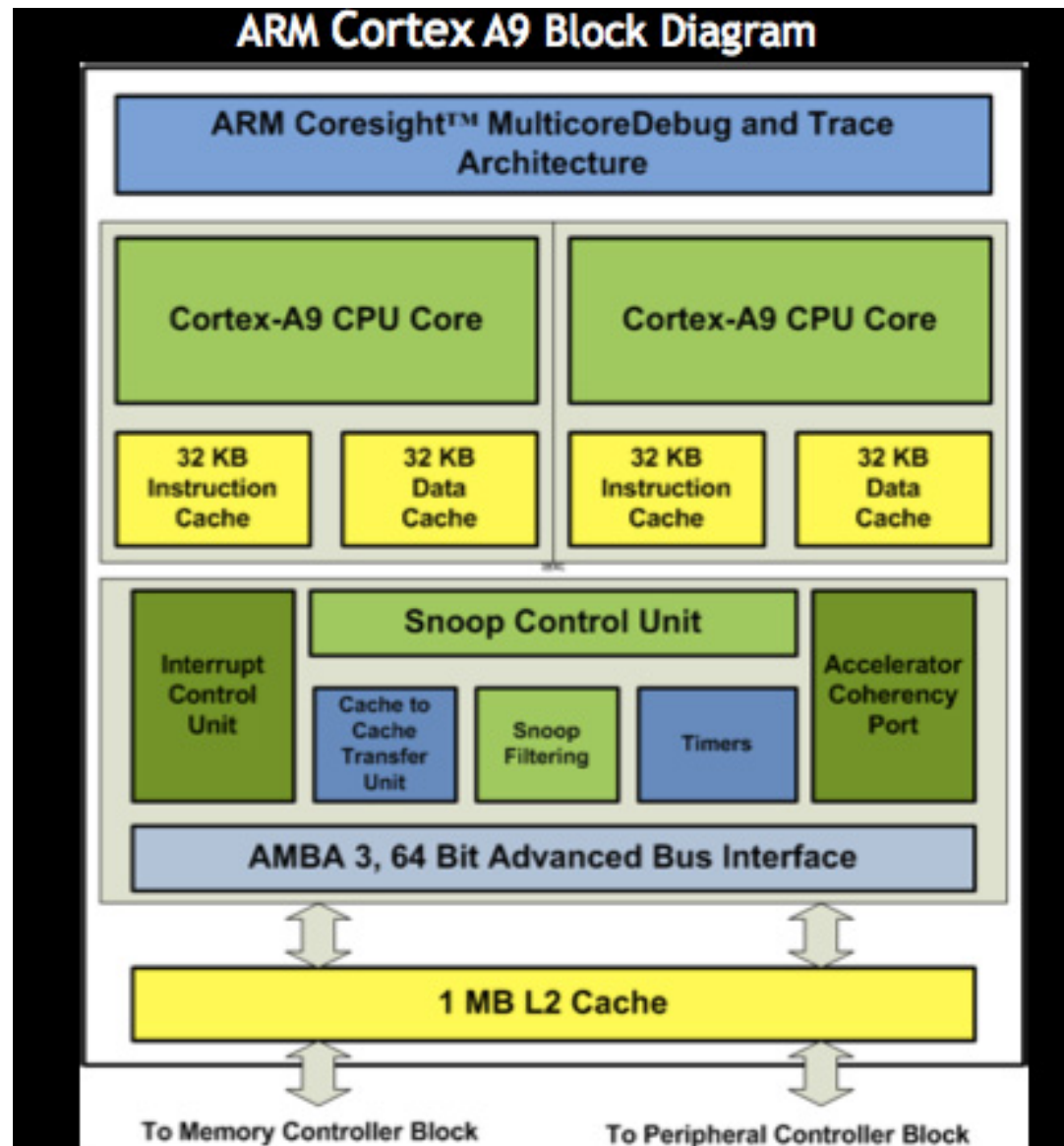
Source: NVIDIA

Figure 1 NVIDIA Tegra 2 with GeForce GPU



Source: NVIDIA

Overview on CPU



Source: NVIDIA



Arch. highlights

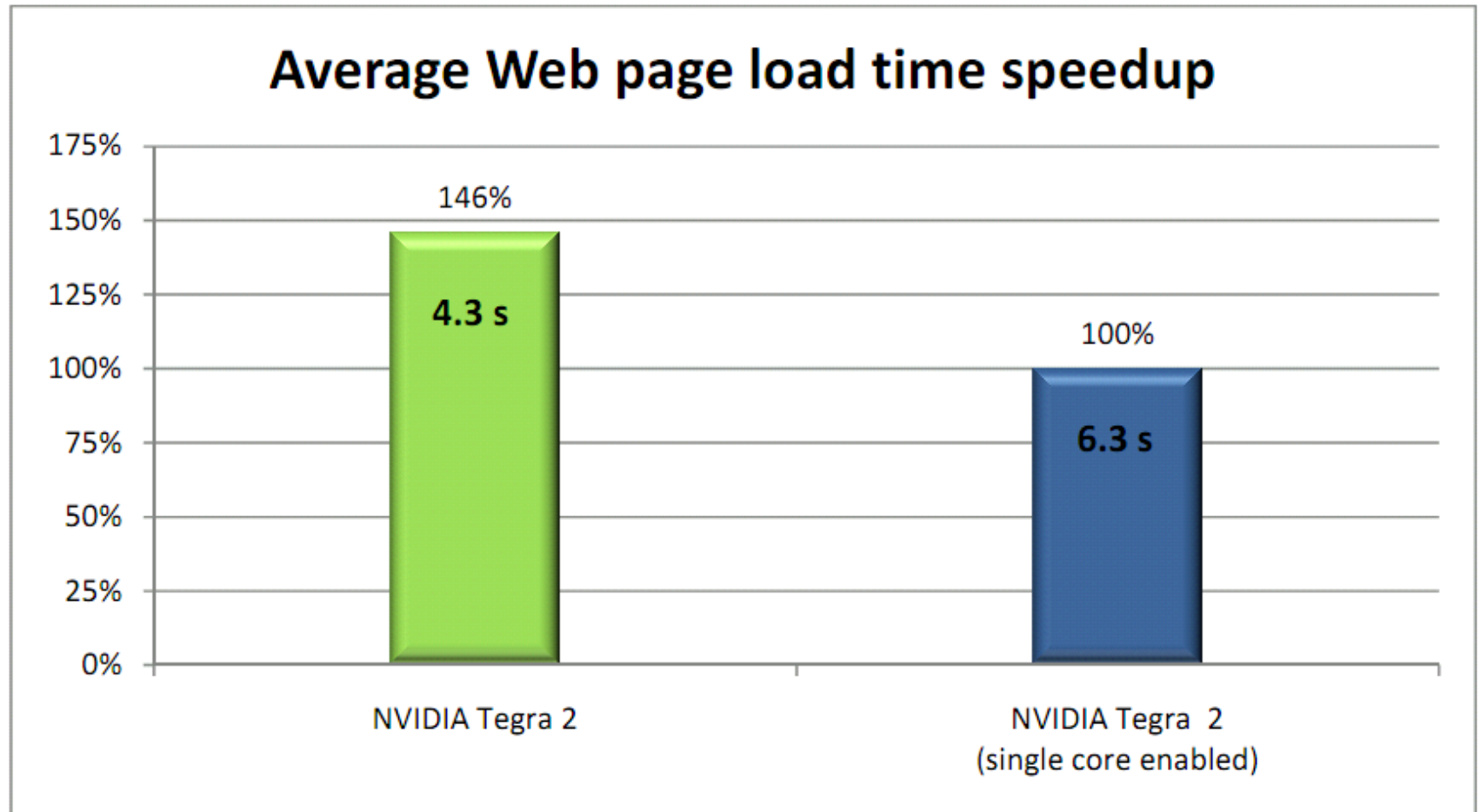
- Shallower pipeline with OoO
 - Improve ILP while reduce speculative penalty
- Multi-core configuration
 - Multi-threaded applications benefit a lot (Web browser, PC games)
- DVFS
 - Maximize battery life vs. Performance



Benefit of Multi-core in Tegra 2

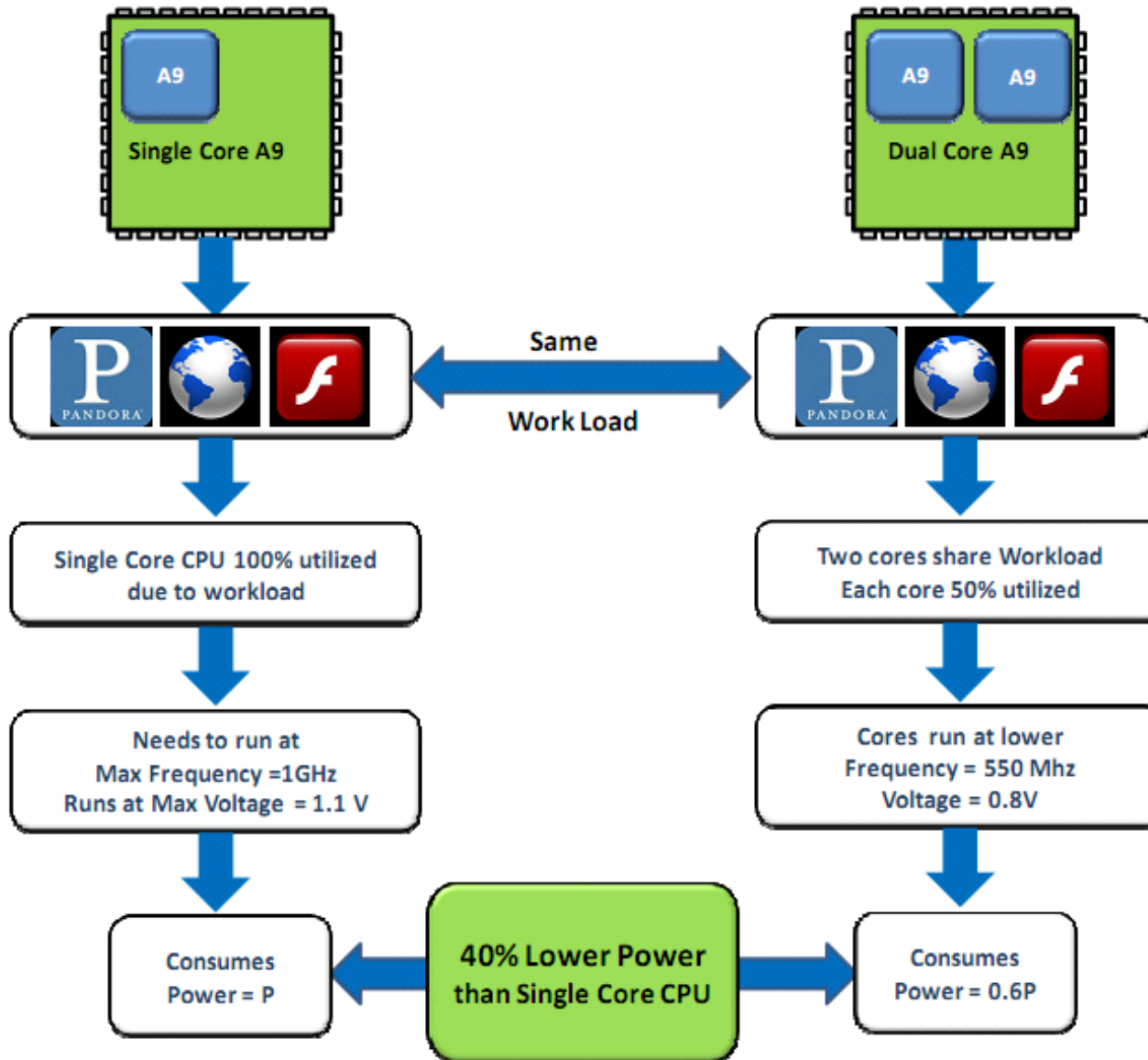
- Faster Web page load times and higher performance per watt
- Lower power consumption
- Higher quality game play experience for advanced console
- Highly responsive and smooth
- Faster multitasking

Fast Webpage load



Source: NVIDIA

Low power with SMP



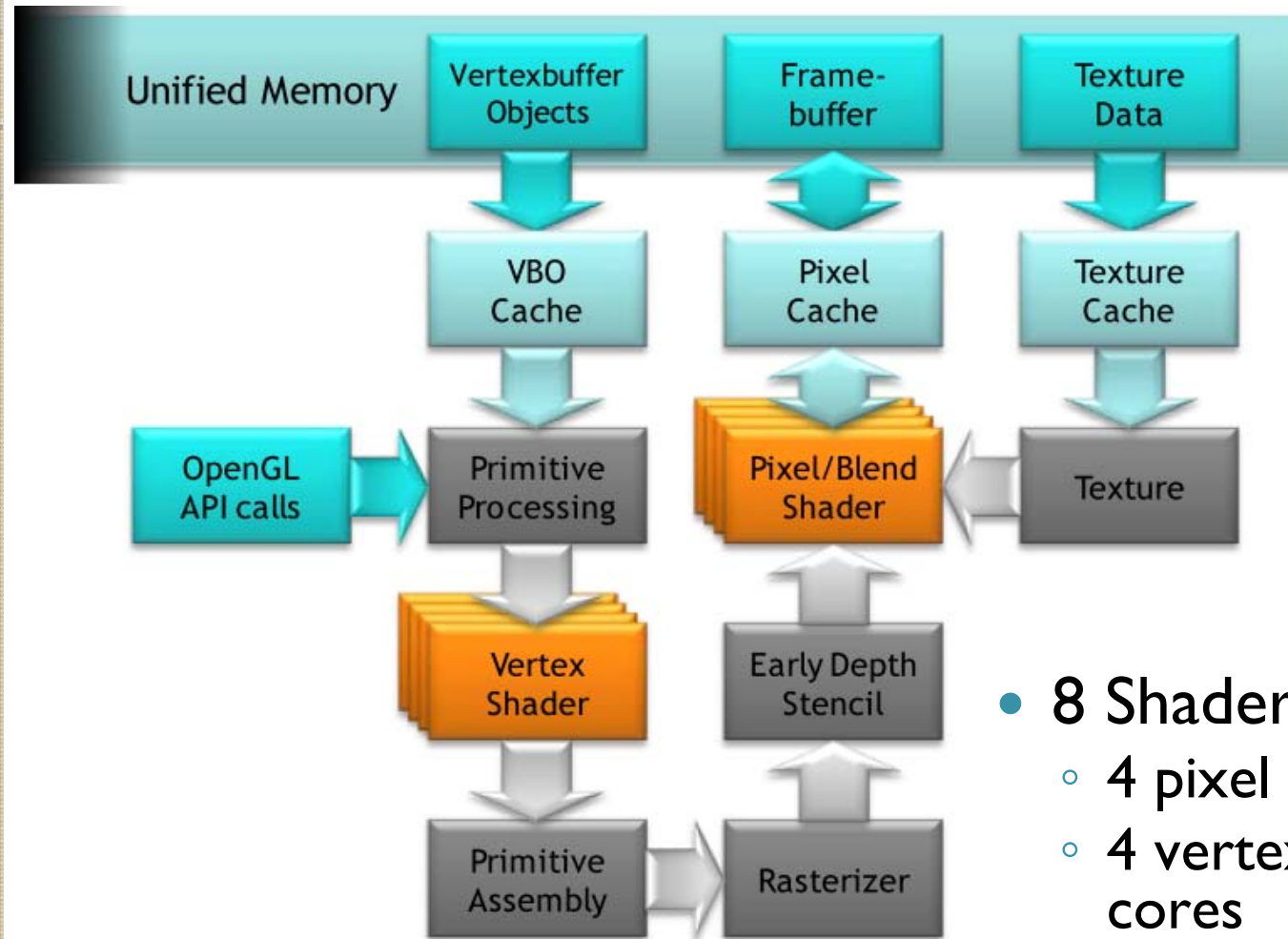
Source: NVIDIA



GPU: Feature

- Early-Z support to filter out non-visible pixels
- Integrated Pixel Shader and Blend Unit for programming flexibility and higher performance
- Pixel Cache, Texture cache, Vertex, and Attribute Caches to reduce memory transactions
- Unique 5x Coverage Sampling Anti-aliasing (CSAA) technique that achieves higher image quality at lower memory bandwidth
- Advanced Anisotropic Filtering (AF) for high detail textures
- A custom Memory Controller developed in-house that improves GPU performance and reduces power consumption
- Numerous Power Management features for ultra low power consumptions.

Ultra Low power GeForce GPU



- 8 Shader cores
 - 4 pixel shader cores
 - 4 vertex shader cores

Figure 4 GeForce GPU Architecture in NVIDIA Tegra



GPU: Memory Controller

- Dynamic Clock Speed Control
 - MC anticipates GPU needs and manages its operating levels
- GPU centric Memory Arbitration
- GPU Request Grouping
 - Group together memory requests into groups based on bank access pattern



GPU: Power Management

- Multi-Level of Clock Gating
- Local Power Management
- Display Request Grouping
- Power-Optimized transistor design
- DVFS

GPU: Performance

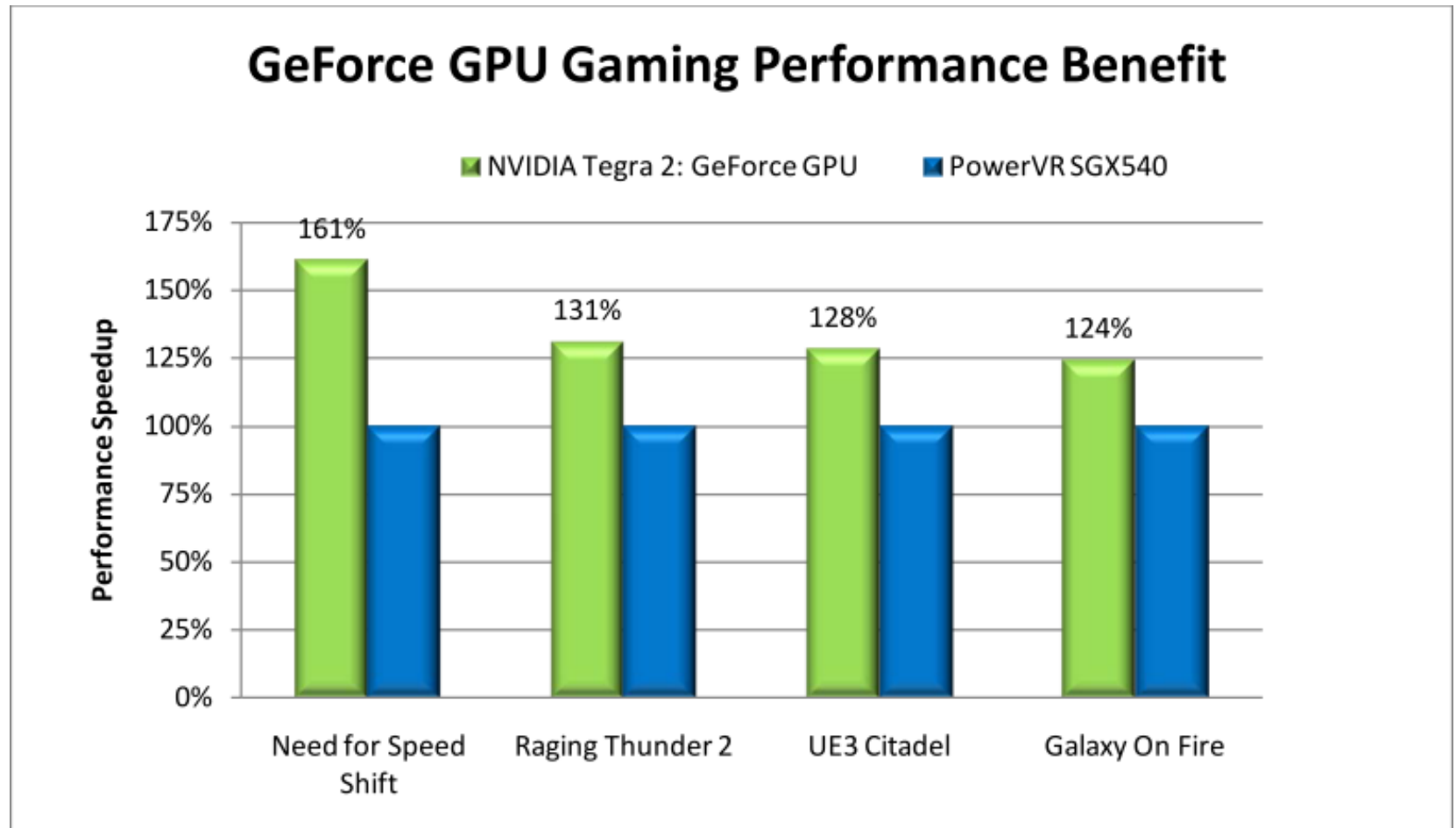


Figure 7 GeForce GPU Performance on Mobile games²

Source: NVIDIA



Other processors

- Audio:
 - NVIDIA acquired PortalPlayer in 2007
- Video encode
 - Able to encode 1080p H.264 video
 - Power consumption remain unknown
- Video decode
 - Decodes 1080p H.264 video at 20Mbps
 - Consumes 400 mW



Other processors

- Image signal processing
 - Support 2 cams: one 12MP, one 5MP
 - Can burst 12MP images at 11 frames/s
- One ARM 7 for chip management
- No cellular modem

SunSpider Javascript Benchmark 0.9

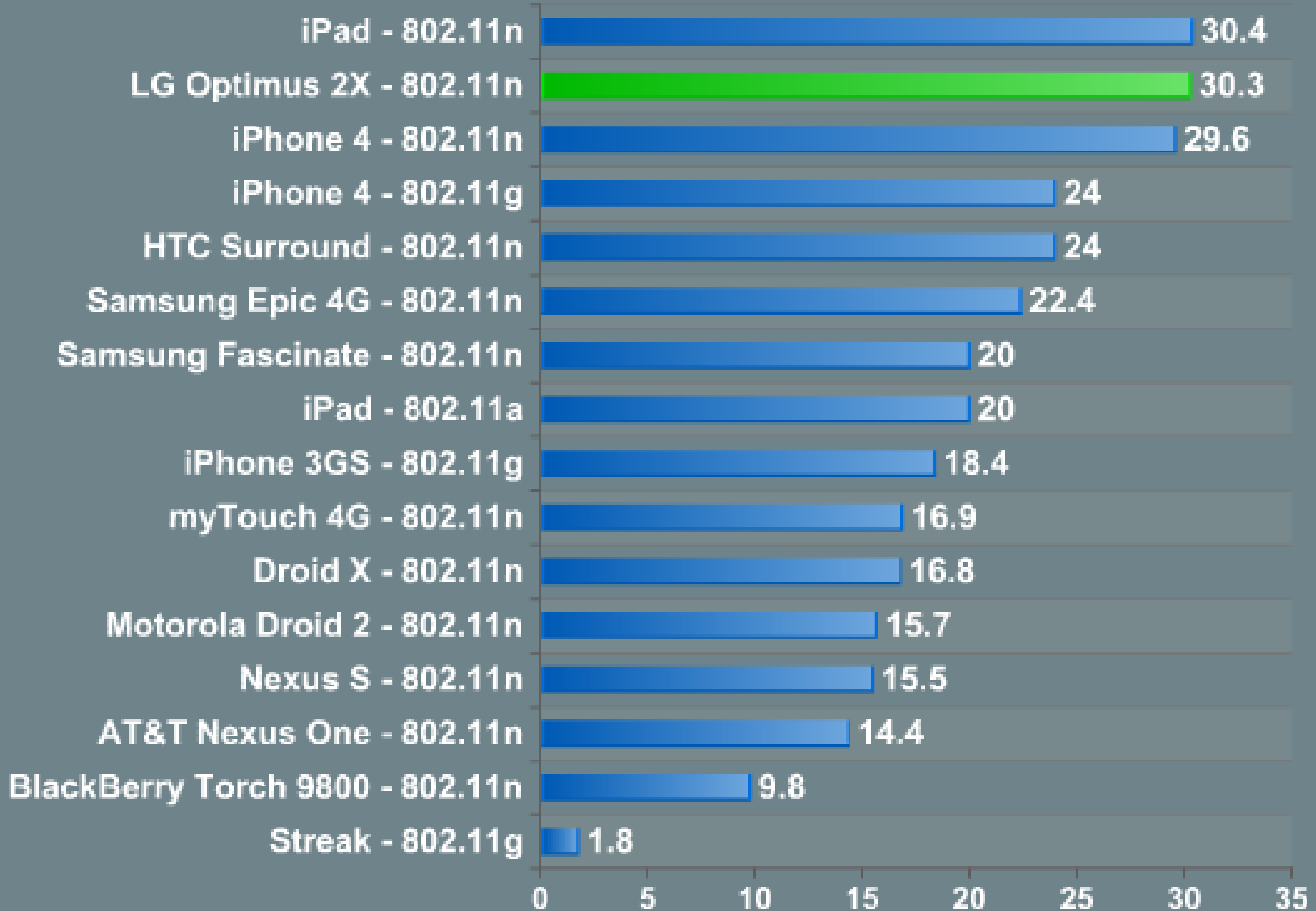
Overall Performance in ms (Lower is Better)



Source: AnandTech.com

WiFi Performance

Local WiFi transfer speed - Mbit/s (higher is better)



Source: AnandTech.com

3G Web Browsing Battery Life

Time in Hours - Higher is Better



Source: AnandTech.com



Reference

- The benefits of Multiple CPU Cores in Mobile Devices, NVIDIA Whitepaper.
- Bringing High End Graphics to Handheld Devices, NVIDIA whitepaper.
- AnandTech reviews
 - [Nvidia introduces Tegra2](#)
 - [Architectural details and design wins](#)



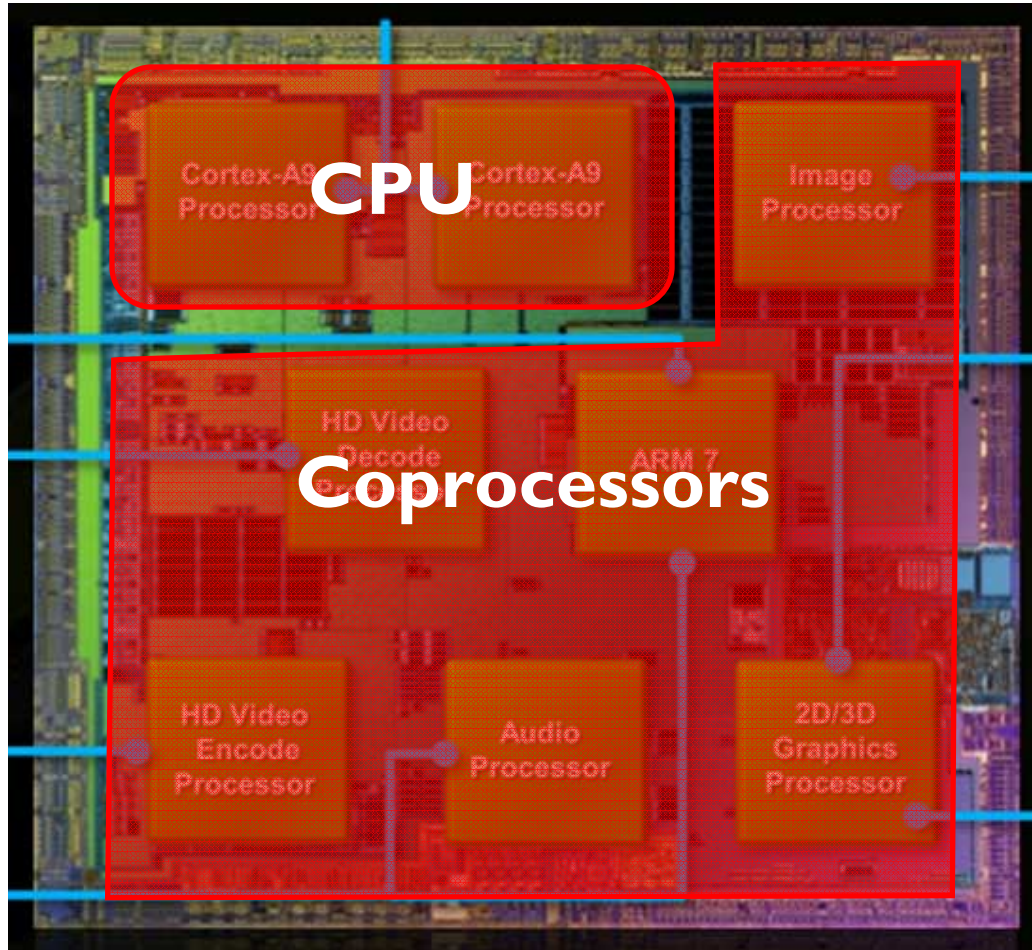
Backups



Target Market

- Smartphone, tablet, and other embedded devices
- Notable devices using Tegra2
 - LG Optimus X2 (cell phone, Feb. 2011)
 - Motorola Xoom (tablet, Feb. 2011)
 - Samsung Galaxy Tab II (tablet, 2011)
 - 2011 Audi A8
- Competitor
 - TI's OMAP 4 (ARM Cortex A9)
 - Qualcomm Snapdragon/Marvel Armamda (ARMv7)

Architectural Overview





A9: differences from A8

- Shallower pipeline (13 stages -> 8 stages)
- OoO capability
- Improved FPU with pipeline
- No SIMD engine (a.k.a NEON)
 - Impact minimal code with 30% die penalty.
 - Maybe added in the future.



Details on CPUs

- Dual-core ARM Cortex A9 at up to 1 GHz
- Dual-issue out-of-order execution
- Clock gated.
- DVFS enabled
- No NEON instruction set (SIMD extension)
- 1 MB shared L2 cache

Physical Comparison

	Apple iPhone 4	Motorola Droid 2	Samsung Galaxy S Fascinate	Google Nexus S	LG Optimus 2X
Height	115.2 mm (4.5")	116.3 mm (4.6")	106.17 mm (4.18")	123.9 mm (4.88")	123.9 mm (4.87")
Width	58.6 mm (2.31")	60.5 mm (2.4")	63.5 mm (2.5")	63.0 mm (2.48")	63.2 mm (2.48")
Depth	9.3 mm (0.37")	13.7 mm (0.54")	9.91 mm (0.39")	10.88 mm (0.43")	10.9 mm (0.43")
Weight	137 g (4.8 oz)	169 g (5.9 oz)	127 grams (4.5 oz)	129 grams (4.6 oz)	139.0 grams (4.90 oz)
CPU	Apple A4 @ ~800MHz	Texas Instruments OMAP 3630 @ 1 GHz	1 GHz Samsung Hummingbird	1 GHz Samsung Hummingbird	NVIDIA Tegra 2 Dual-Core Cortex-A9 (AP20H) @ 1 GHz
GPU	PowerVR SGX 535	PowerVR SGX 530	PowerVR SGX 540	PowerVR SGX 540	ULV GeForce @ 100-300 MHz
RAM	512MB LPDDR1 (?)	512 MB LPDDR1	512 MB LPDDR1	512 MB LPDDR1	512 MB LPDDR2 @ 600 MHz data rate
NAND	16GB or 32GB integrated	8 GB integrated, preinstalled 8 GB microSD	2 GB, 16 GB microSD (Class 2)	16 GB Integrated	8 GB integrated (5.51 GB internal SD, 1.12 phone storage), up to 32 microSD
Camera	5MP with LED Flash + Front Facing Camera	5 MP with dual LED flash and autofocus	5 MP with auto focus and LED flash	5 MP with Autofocus, LED Flash, VGA front facing, 720P Video	8 MP with autofocus, LED flash, 1080p24 video recording, 1.3 MP front facing
Screen	3.5" 640 x 960 LED backlit LCD	3.7" 854 x 480	4" Super AMOLED 800 x 480	4" Super AMOLED 800 x 480	4" IPS-LCD 800x480





Signal Attenuation Comparison in dB—Lower is Better			
	Cupping Tightly	Holding Naturally	On an Open Palm
LG Optimus 2X	13.7	9.3	5.9
Nexus S	13.3	6.1	4.3
Droid 2	11.5	5.1	4.5
BlackBerry Torch	15.9	7.1	3.7
Dell Streak	14.0	8.7	4.0
Droid X	15.0	5.1	4.5
iPhone 4	24.6	19.8	9.2
iPhone 3GS	14.3	1.9	0.2
HTC Nexus One	17.7	10.7	6.7

Source: AnandTech.com