

# Processor Progression In Mobile Phones

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**ABSTRACT**— Mobiles has become an important part of our existence , A mobile processor is found in mobile phones. A CPU chip is intended for mobile phones, it's generally housed during a smaller chip package, however a lot of significantly, so as to run cooler, it uses lower voltages than its desktop counterpart and has a lot of "sleep mode" capability. A mobile processor will be throttled right down to totally different power levels or sections of the chip will be turned off entirely once not in use. Further, the clock frequency could also be stepped down underneath low processor load. This stepping down conserves power and prolongs battery life. Technological advancements have resulted in important changes within the processor design of mobile phones; remodeling the everyday mobile phones of 1990's to trendy good phones. the look and preparation of mobile processors over the years is basically suffering from Communication, performance, and low-power operation. The transition from analog to digital telecommunication has resulted in mobile devices delivering a large vary of knowledge services. To support these services, processor design has currently become far more advanced. Mobile processors area unit growing with every passing generation. The goal of this paper is to review numerous processor structures for mobile phones.

**KEYWORDS**— Mobile Processor, DSP, SoC, Qualcomm, Nvidia, ARM processors.

## 1. INTRODUCTION

Smartphone hardware principally consists of application processors (System-on-a-Chip), RAM (mobile SDRAM/mobile DDR), DSP, computer hardware (ARM processor), etc. Processors that are used for mobile phones are subject to style metrics that emphasize price, time-to-market, and low power. as a result of the affected resources of power and price, and therefore the period computation necessities, the processors to be used in mobile applications possess variety of distinct characteristics like restricted programmability.

Processor design of mobile devices delivering information services should offer support for rather more advanced program dynamic operative environments, and support for added services. to supply for these further necessities,

advanced architectures could embrace multiple DSP's or hardware coprocessors.

## 2. MOBILE PROCESSOR CHIPSETS TYPES

### 2.1 Digital Signal Processor

There are 2 distinct approaches for implementation of cellular handsets. One approach emphasizes programmable DSP's, whereas the opposite approach utilizes ASIC (Application-specific integrated circuit) techniques.

DSP may be a specialized microprocessor used for mobile phones. traditionally DSP's were designed around single complete integrated circuits (ICs). Embedded DSP's area unit currently wide adopted for VLSI styles. Programmable DSP's area unit dominant in wireless phone marketplace for digital cellular telecom.

Earliar generation of mobile communications i.e. 1G systems used analog transmission with the constraints of requiring a lot of power for transmission and permitting restricted users.

Global System for Mobile Communications (GSM) commonplace evolved once 1st generation of mobile communication for analog cellular networks. DSP processors type one in all the foremost necessary categories of mobile embedded processors in second generation i.e. 2G systems.

DSP architectures are most popular over ASIC as a result of shorter product life cycle and that they are extensively employed in GSM mobiles. Programmable DSP's give a cheap and versatile design for cellular telephones. AT&T in 1979 introduced 1st DSP, and afterwards Texas Instruments came up with alternative DSP's.

Traditionally, DSP used Harvard design that physically separates storage and signal pathway for directions and knowledge. this is often in distinction with von Neumann design, wherever knowledge and directions are keep within the same memory. As shown in Figure one, it equires knowledge memory and instruction memory to execute directions. it's separate knowledge and instruction buses permitting synchronous transmission. afterwards, the output

of multiplication unit connects to an adder, thereby adding and saving all partial results for any process

This design leads to fewer cycles for executing a selected operate because it allows high memory information measure and multiple quantity operations. Multiply-accumulate (MAC) directions are normally related to DSP architectures.

## 2.2 System on Chip (SoC)

SoC is brief for System on a Chip, an computer circuit that mixes all the first elements of a laptop into one chip. think about your central processor, graphics card, memory controller and alternative elements all rolled into one chip, that's primarily an SoC. This way, French telephone manufactures will merely drop this give their device and reap the advantages of the chipset at once, instead of having to implement the central processor, GPU, etc. manually. Below, we've 2 well-liked SoCs, the primary being an Nvidia Tegra three and also the second, a Qualcomm snapdragon S4 SoC. What goes on within an SoC

Notice that Nvidia's SoC solely options the GPU, memory controller and video out streams whereas Qualcomm has managed to package all of that in addition because the wireless radios like GPS, Wi-Fi, LTE, etc in addition in this single chip. this is often as a result of the Qualcomm uses a smaller fabrication process (28nm) for the S4 chip permitting them to feature additional elements into one piece of silicon. Nvidia on the opposite hand remains on the 40nm fabrication for Tegra 3 thus that's why they can't cram in additional than that while not increasing the dimensions of the chip.

## 2.3 ARM Processors for Mobiles

Today, a majority of mobile phones, tablets, wireless routers, digital media players, hand-held gaming consoles and lots of pc peripherals are powered by an ARM microprocessor. similar to Intel and AMD, ARM is a 32-bit micro chip originally created by acorn Computers back in 1987. Since then, ARM has been the well-liked micro chip by any and every one corporations looking for an inexpensive and additional significantly, powerless chip for moveable devices. ARM uses a completely different design as compared to Intel and AMD, who've cursed with the x86 design and thus, all 3 corporations have jubilantly co-existed. With Windows eight geared up to support ARM devices also, that equation might shortly modification.

One chip to rule all of them Since the ARM design is licensable, corporations will either get associate subject licence to style their own, customized central processor or just make a choice from one in every of ARM's ready-to-ship core

styles. well-liked core style from ARM include ARMv7, ARM9, ARM11, Coretex-A8, Cortex-A9 and also the most up-to-date, Cortex-A15. corporations like Nvidia, texas Instruments, Samsung and Apple (to name a few) merely choose one in every of these styles and packages them together with a GPU and alternative elements, into their own branded SoC. However, SoC makers like Qualcomm favor to style their own custom CPUs instead of associate with the gang. 'Krait' is that the latest central processor, designed by Qualcomm and is employed in their new snapdragon S4 SoC.

## 3. COMPARATIVE STUDY OF MOBILE PHONE PROCESSORS

Qualcomm Snapdragon, Nvidia Tegra are among the most widely used mobile processors.

### 3.1 Qualcomm Snapdragon Processors

Snapdragon is a family of mobile system on a chip (SoC) processor design provided by Qualcomm.

In U.S. markets, Qualcomm leads the approach in android phone implementations with the snapdragon SoC (System-on-Chip) platform. flower starts with an ARM-compatible central processor core of Qualcomm's own style. Currently, the central processor core in snapdragon processors is called krait, and is loosely comparable in speed to ARM's Cortex A15 reference style.

Paired with krait is Qualcomm's Adreno graphics technology. This GPU line began life at ATI beneath the brand name Imageon, and was picked up by AMD in 2006 once it purchased ATI. two years later, AMD sold-out off the Imageon technologies to Qualcomm, that re-branded them Adreno. It's a nery move Qualcomm's part: Adreno is admittedly anagram of Radeon, the brand name still utilized by AMD for its graphics cards.

Qualcomm was initial out of the 4G LTE gate with an integrated SoC implementation for the wireless standard. This place Qualcomm at a huge advantage in markets just like the U.S., wherever LTE support became vital feature. Direct SoC integration additionally earned the snapdragon a direct a lot of phones, because the different is to feature a separate LTE modem chip—thus raising value, energy usage and producing complexness for phone makers.

Currently, the snapdragon 800 series is Qualcomm's high giving, that includes up to four krait cores running at up to two.46 GHz, and partnered with Adreno 330 graphics. Arguably, this represents the foremost comprehensive

processor package for android devices nowadays, providing wonderful performance altogether areas among an inexpensive power budget. Snapdragon-based devices additionally get the lion's share of post-release read-only memory development from enthusiasts.

Just round the corner is that the snapdragon 805, a platform refresh that may feature quicker krait cores, AN improved Adreno GPU, and quicker RAM information measure. Oddly, Qualcomm's initial 64-bit mobile elements can arrive this year within the style of the low- to mid-range snapdragon 410. High-end elements area unit expected shortly later.

**Figure 1: Qualcomm Snapdragon Processor**



### 3.2 ARM Cortex Processors

ARM Cortex processors cores are categorized into the following variants:

- Cortex-A Processors (ARM Application Processors)
- Cortex-R Processors (ARM Embedded Real-time Processors)
- Cortex-M Processors (ARM Embedded Processors)
- SecureCore Processors (ARM Secure Processors)

As an example, contemplate the design of ARM Cortex-A8 portrayed in Figure four. This design is predicated on neon SIMD media and signal process technology for providing

audio, video, and 3D graphics to mobile applications. Instruction set design of ARM Cortex-A8 implements Thumb-2 instruction set encoding consisting of 16-bit long directions that need less external memory. AMBA (Advanced Microcontroller Bus Architecture) bus interface supports input and output information buses that are either sixty four or 128-bit wider. It performs L2 cache fills and non-cacheable accesses for each instructions and information.

**Figure 2: ARM Cortex-A9 Processor**



A single core ARM Cortex A8 processor with 1.4 GHz clock speed was considered reasonably enough till 2011. In the year 2014, ARM processors clocked at 3 GHz will become a reality. These upcoming 20 nm manufactured processors are expected to offer 25% less power consumption and will allow up to 30% faster clock speeds.

Mobile computing is gearing up for a drastic change this year with the advent of 64-bit ARM based processors which are expected to provide up to 50% performance improvement over existing 32-bit ARM processors. ARM's new Cortex-A50 processor series based on the ARMv8 architecture includes the Cortex-A53 and Cortex-A57 processors. The Cortex-A57 is a performance-oriented applications processor, while the Cortex-A53 is a power-efficient application processor.

In the near future, Android 5.0 will efficiently utilize the new ARMv8 64-bit architecture. Apart from the proposed 64-bit architectures, upcoming mobile phones will be equipped with 4 GB of RAM to support increasing complexity of 3D games on Android.

### 3.3 Samsung Exynos 5 Processor

Samsung has been producing SoCs based on ARM architectures for more than a decade. In fact, Samsung chips appeared in every iPhone released before the iPhone 4.

Samsung's current Exynos series SoCs are fairly traditional ARM variants, featuring Cortex A9 and A15 cores, and ARM's own Mali GPU design. However, a few Samsung chips—such as the Exynos 5 5410 found in one variant of the Galaxy S4—use PowerVR's potent SGX core to handle graphics. PowerVR's excellent GPU designs are most commonly found in Apple products, which is too bad because Exynos could use a little love when it comes to GPU horsepower.

**Figure 3: Samsung Exynos 5 Processor**



The Exynos 5 Octa features 4 “big” high-performance cores paired with 4 “little” cores that offer lower performance but big battery savings.

While the Exynos 5's raw CPU performance is generally superior to Qualcomm's Krait performance, the Mali GPU falls behind competing Adreno and PowerVR graphics solutions. Samsung's own Galaxy Note 3 implementation is a good example of this. The Note 3 variants featuring Snapdragon chips offer more features and a better user experience, despite being virtually identical to the versions that include Samsung's own Exynos chips.

A15 cores are power hungry, so ARM implemented a scheme called “big.LITTLE” wherein each high-performance core is shadowed by a lower-power, lower-performance core that takes over whenever workloads permit. The current crop of Exynos 5 Octa SoCs employs this feature to keep the A15's appetite for power in check, although some implementations of big.LITTLE have cache issues that hinder performance.

Looking forward, Exynos 6 promises to bring cutting-edge 64-bit hardware and integrated 4G LTE to the table. Samsung says the caching problems that held back earlier variants of big.LITTLE have been resolved, and we should see Exynos 6 by springtime, perhaps in the Galaxy S5.

That being said, Samsung's phones and tablets are most appealing for reasons beyond processor performance, focusing instead on features such as advanced OLED screens and sophisticated stylus input. The conservative route of going with ARM's reference designs allows Samsung's engineers to look for more novel ways to differentiate their hardware. Given their market share, it appears Samsung may be on to something with this strategy.

### 3.4 Nvidia Tegra Processors

Tegra is a SoC series for mobile devices developed by Nvidia. It integrates ARM architecture CPU, graphics processing unit (GPU), memory controllers, etc. on a single package. It enables high performance and low power consumption for audio/ video applications.

Nvidia Tegra 4 processor is a quad-core Soc with increased GPU cores, faster clock cycles, and improved efficiency. The GPU architecture of Tegra 4 is shown in Figure 6. Vertices are processed by six VPE (vertex processing engine) units. Next, vertices are cached by IDX unit. Vertices are then passed to raster engine, which produces pixel fragments. Early-Z unit tests pixel fragments for Z-depth and passes only visible pixels. Early-Z processing in Tegra 4 GPU architecture results in improved performance and power savings. GPU includes four pixel fragment shader pipes which implements VLIW architecture. Each pixel shader unit also contains a texture filtering unit, with their own L1 and L2 cache.

According to an analysis of upcoming ARM processors, it was revealed that Nvidia's Tegra 4 SoC beats the best Qualcomm Snapdragon processor in terms of performance. Though Nvidia have designed a technically faster SoC, but when it comes to power efficiency Qualcomm Snapdragon processors have an edge.

Nvidia has recently launched next generation mobile processor, Tegra K1. It is a mobile processor with 192 graphics cores for mobile gaming applications. Nvidia K1 was launched with a support for two versions: traditional 32-bit “4+1” ARM cores like Tegra 4, and dual core 64-bit version. It is said that Tegra K1 is even more powerful than either the Xbox 360 or the PlayStation 3

**Figure 4: Nvidia Tegra Processor**

### 3.5 Intel Atom Processor

This is a processor manufactured by Intel. It's supported X86 design, average, than on ARM system. Intel is currently serious about conquering mobile device market.

The current version of Atom processors are totally different from those seen on netbooks. The Smartphone version has upgrade performance, speed, and fewer power consumption. Atom processors are good in analyzing websites and taking part in internet

based games and videos. Recently Atom processors were created for Android suitable. With increased performance and since of recent changes, we are able to see slighter variety of handsets within the future from their partners Motorola and Orange. Intel Atom processors are the most effective preferred for using internet primarily based applications on Smartphones and Tablets.

The list components mobile processors that goes to require the market by storm very presently and also the ones that we want to observe out for within the near future.

**Figure 5: Intel Atom Processor**

## 4. MOBILE PHONE GRAPHIC PROCESSORS (GPU)

Unlike the CPU component in an SoC that's primarily supplied by ARM, the graphics portion is manufactured by multiple vendors which gives companies the flexibility to pick and choose which GPU goes best with the CPU in their SoC. While back in the day, the primary job of the graphics card was rendering 3D images and displaying them on the screen, today GPUs are used for much more than just playing games and are as crucial as the CPU, if not more. Today's operating systems like Google's Ice Cream Sandwich rely heavily on the GPU since the interface and all the animations are rendered on the graphics chip, which is how you're able to get the buttery smooth transition effects. It also comes in handy when watching HD videos. Just like its PC component, a graphics chip essentially has more cores than a CPU thereby allowing it distribute the load better and leaving the CPU free for other tasks. Take Nvidia's Tegra 3 for instance, this SoC packs in 12 GPU cores. Below are some of the most popular vendors for GPUs.

### 4.1. ARM Mali

Mali is a series of GPUs produced by ARM. Unlike other GPUs though, the Mali chip doesn't actually have any display controller built-in to drive the LCD panel. Instead, it's just a pure 3D engine that does the job of rendering graphics into memory. The most popular chip is the Mali-400 MP, a quad-core GPU that's used in plenty of SoCs like Samsung's Exynos and ST-Ericsson's NovaThor.

### 4.2. Qualcomm Adreno

Previously known as Imageon, ATI developed this line of media processors back in 2002 for handheld and mobile devices. It later came to be known as AMD Imageon when AMD bought ATI in late 2006. After some company restructuring, AMD officially discontinued this line of mobile media chips in 2008 only to be bought by Qualcomm later that year for \$64 million. After Qualcomm stepped in, they changed the branding to Adreno since AMD retained the Imageon title. Adreno has since been used in Qualcomm's Snapdragon SoCs, their most popular ones being the Adreno 205, Adreno 220 and the most recent, Adreno 225.

### 4.3. Imagination PowerVR

PowerVR is a division of Imagination Technologies that started out making graphics solutions for desktop PC market but over the years, dropped out and have since been making low powered media chips for mobile devices. PowerVR GPUs aren't manufactured by PowerVR themselves but instead, they

licence their design and patents to other companies like Texas Instruments, Intel, Samsung, Apple, etc. Their PowerVR SGX series have been quite popular and featured in many prime-time commercial products.

#### 4.4. Nvidia Geforce

The name Geforce is synonymous with graphics cards ever since they introduced it, way back in 1999. NVidia developed these graphics chips in-house and till now, only feature in their own Tegra SoC. Their latest Tegra 3 SoC ups the ante by offering a 12-core GPU making it roughly three times more powerful than its predecessor.

### 5. CONCLUSION

Different vendors are working towards the development of more power efficient mobile processor architectures by looking at the future of mobile computing. All the modern mobile processors are basically ARM-based, designated with fancy names by different cellular companies.

With newer versions of mobile CPU's we will have more powerful Smartphone with new GPU cores, memory interfaces, and many more advanced features. Future mobile SoC's will explore next generation processor architecture to improve the device performance. Mobile processing unit manufacturers are working hard to develop powerful cell phone devices.

To support next-generation data-centric mobile devices, processor architecture has to be designed considering new approaches. Still, the development in mobile processors is driven by factors such as low-power consumption, user interface performance, time to market, etc.

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