Race for faster, high performance chip (SoC) for mobile computing built on microelectronic architecture and 7nm processes

A system on a chip or system on chip (SoC) is an integrated circuit (also known as a “chip”) that integrates all components of a computer or other electronic system. Whereas a motherboard houses and connects detachable or replaceable components, an SoC will typically integrate a CPU, graphics and memory interfaces, hard-disk and USB connectivity, random-access and read-only memories and secondary storage on a single circuit die.

Similar to how a microcontroller integrates a microprocessor with peripheral circuits and memory, an SoC can be seen as integrating a microcontroller with even more advanced peripherals like graphics processing unit (GPU), Wi-Fi module, or one or more coprocessors. These components typically include a central processing unit (CPU), memory, input/output ports and secondary storage – all on a single substrate. It may contain digital, analog, mixed-signal, and often radio frequency signal processing functions, depending on the application.

As they are integrated on a single electronic substrate, SoCs consume much less power and take up much less area than multi-chip designs with equivalent functionality. Because of this, SoCs are very common in the mobile computing and edge
computing markets. Systems on chip are commonly used in embedded systems and the Internet of Things.

Systems-on-chip can be applied to any computing task. However, they are typically used in mobile computing such as tablets, smartphones, smartwatches and netbooks as well as embedded systems and in applications where previously microcontrollers would be used.

In the microelectronics space, Intel was once the champion. That position is now being challenged, not by hot new upstarts but by established tech players moving in on this space, speaking at ICT 2018, Prof Alberto Sangiovanni-Vincentelli said. Apple’s A11 system-on-a-chip, for example, was singled out by Vincentelli as an industry frontrunner. And it’s not just Apple, Vincentelli noted. Google, Facebook and others are designing their own chips because they have recognised this is a vital opportunity. “The basic microelectronic architecture is going to be key,” said Vincentelli. And so, the race is on for the company that can build the machinery that can do these essential AI computations the best and the fastest.

The chips and transistors, which form the brains of our smartphones and devices, have been shrinking each year and are fast approaching a point where it will be very hard to shrink them further. Current flagship SoCs are as tiny as 7 nanometers or 7 billionths of a meter. That’s how small the overall frame of the chipset has become. In fact, there will be even smaller 5nm chips next year. But that’s when things will start to get difficult. However in May 2019, Samsung has announced a breakthrough in chip manufacturing that will help foundries pursue miniaturization to 3nm. And the Korean giant has a head start as it is two to three years ahead of Intel
and around 12 months of TSMC, said Handel Jones, chief executive of consulting firm International Business Strategies.

**ARM’s DynamIQ is the future of multi-core SoCs**

An ARM processor is one of a family of CPUs based on the RISC (reduced instruction set computer) architecture developed by Advanced RISC Machines (ARM). RISC processors are designed to perform a smaller number of types of computer instructions so that they can operate at a higher speed, performing more millions of instructions per second (MIPS). By stripping out unneeded instructions and optimizing pathways, RISC processors provide outstanding performance at a fraction of the power demand of CISC (complex instruction set computing) devices.

ARM processors are extensively used in consumer electronic devices such as smartphones, tablets, multimedia players and other mobile devices, such as wearables. Because of their reduced instruction set, they require fewer transistors, which enables a smaller die size for the integrated circuitry (IC). The ARM processor’s smaller size, reduced complexity and lower power consumption makes them suitable for increasingly miniaturized devices.

The simplified design of ARM processors enables more efficient multi-core processing and easier coding for developers. While they don’t have the same raw compute throughput as the products of x86 market leader Intel, ARM processors sometimes exceed the performance of Intel processors for applications that exist on both architectures.
In March 2017, ARM unveiled its next-generation multi-core micro-architecture designed to boost the performance and efficiency of multi-core Cortex-A processors, which form the basis of many mobile and server SoCs. Known as DynamIQ, the new technology will be heading to automotive, smart home, smartphone, and other connected device markets in the near feature.

The Arm Cortex-A76 CPU is the second generation premium core built on DynamIQ technology. DynamIQ is an evolution of ARM’s existing big.LITTLE technology, the heterogeneous computing architecture that connects together and manages dual ARM CPU core clusters in multi-core configurations. DynamIQ takes this a step further by enabling big.LITTLE configurations of up to eight different CPU cores on a single compute cluster for the first time. This offers SoC designers much greater flexibility than ever before.

Paired with a Cortex-A55 CPU in a scalable DynamIQ big.LITTLE configuration, the Cortex-A76 delivers laptop-class performance with mobile efficiency, bringing the mobile experience (fast responsiveness, always on, always connected) into all classes of intelligent mobile compute devices. With superior energy efficiency and far greater single-threaded performance, the Cortex-A76 CPU extends battery life and improves user experience for sustained high performance across even the most complex compute tasks.
Qualcomm announces Snapdragon 675 with faster cores and triple-camera support

Qualcomm has announced the Snapdragon 675, a mid-range smartphone SoC with some high-end features. Perhaps most notable is the fact that its new Kryo 460 architecture is built around ARM’s Cortex-A76 cores, which are designed for flagship devices and haven’t yet made their way into a Qualcomm chip. (The first major SoC with A76 is Huawei’s Kirin 980.)

The Snapdragon 675 has two performance-focused cores at 2.0GHz alongside six 1.78GHz cores designed for power efficiency. For comparison, the current flagship Snapdragon 845 uses four 2.8GHz performance cores based on the Cortex-A75, so it’ll still be a lot faster. The 845 is also built on a 10nm process versus the 675’s 11nm. But as Anandtech notes, it’s unusual to see Qualcomm launch a new CPU design on a mid-range product, particularly considering that the results will probably outperform the ostensibly higher-tier (and not exactly old) Snapdragon 710.

Cores aside, the Snapdragon 675 appears to have designed for the reality that high-end features are no longer the exclusive preserve of flagship phones. The new image signal processor has been built with triple-camera setups in mind, while there are gaming enhancements for specific titles that sound similar to Huawei’s GPU Turbo optimizations. The 675 also includes Quick Charge 4+ support and a faster AI engine.

Qualcomm expects the Snapdragon 675 to make its way into consumer phones in the first quarter of 2019, so don’t be
surprised if it seems like every new device has three cameras on the back by then.

**Apple calls A12 Bionic chip ‘the smartest and most powerful chip ever in a smartphone’**

Apple has unveiled its latest chip for the new batch of iPhones: the A12 Bionic. The company says it’s the industry’s first ever 7nm chip and Phil Schiller, on stage in Cupertino, introduced it as the “the smartest, most powerful chip ever in a smartphone.”

It has a six-core CPU (with two “performance” cores and four “efficiency” cores), a four-core GPU (which is up to 50 percent faster than the A11’s), and an updated Neural Engine, a special part of the chip designed to handle AI tasks.

While last year’s chip had a two-core Neural Engine, the A12 Bionic bumps that up to eight cores. And while the old Neural Engine could crunch through 600 billion operations per second, the new version can handle 5 trillion operations per second.

**The move to 7nm manufacturing**

Apple says this is the industry’s first 7nm chip. Apple’s A11 Bionic found in the iPhone 8, 8 Plus, and X were produced using TSMC’s 10nm manufacturing process. The A12 will be produced with TSMC’s 7nm process—in fact, it should be the first widely-available consumer product made with a 7nm process, anywhere.
The company paints a very rosy picture. Compared to the 10nm process that the A11 Bionic was made with, the company says 7nm offers “1.6X logic density, ~20% speed improvement, and ~40% power reduction.” Where the A11 had an impressive 4.3 billion transistors, we estimate the A12’s transistor count will fall somewhere between 5.5 and 6 billion.

Huawei launches Kunpeng 920 chip to bag big data and edge computing

Huawei has unveiled a new ARM-based CPU called Kunpeng 920, designed to capitalise on the growing euphoria building around big data, artificial intelligence and edge-computing. The CPU was independently designed by Huawei based on ARMv8 architecture license, with the team claiming it improves processor performance by optimizing branch prediction algorithms, increasing the number of OP units, and improving the memory subsystem architecture. The Kunpeng 920 performs 25% higher than the industry benchmark, operates at a better power efficiency than its peers and will boost the development of big data, the company said. The company also unveiled a new server based on the processors.

The Kunpeng 920 is built using the cutting edge 7-nanometer process and uses the semiconductor architecture of ARM Holdings, Shenzhen-based Huawei said in a statement on Monday. The new chips would compete with the dominant x86 server architecture used by US giants Intel and Advanced Micro Devices Inc.
Huawei’s 7nm Kirin 980 chip

Huawei Consumer Business Group India in Sep 2018 have also unveiled the Kirin 980, new chipset commercial SoC manufactured with Taiwan Semiconductor Manufacturer Company’s (TSMC) 7nm process.

The company claimed it to be a technological marvel which aims to bring superlative performance, improved smartphone photography and videography experience, the most advanced mobile AI experience and outstanding connectivity anytime, anywhere to consumers.

The 980 is also the first to use Cortex-A76 cores, dual neural processing units, the Mali G76 GPU, a 1.4 Gbps LTE modem as well as support faster RAM. Kirin 980 uses a new octa-core architecture that mixes big, little and medium cores for more efficiency.

The two big cores run at 2.6GHz and kick in when taxing tasks like gaming are in progress. Two middle cores with clock speeds of 1.92GHz support less-intensive processes like browsing or posting to social media, while the four little Cortex-A55 cores run at 1.8GHz. These are best used background processes or playing music, since they sap less energy. The processor can also tap different types of cores at once to maximize performance and efficiency.

The Kirin 980 also packs two Neural Processing Units (NPUs), which Huawei says helps devices run AI tasks faster and better than other chips. The Kirin can recognize up to 4,500 images
per minute on the Resnet 50 model, while Qualcomm’s Snapdragon 845 and Apple’s A11 identified 2,371 and 1,458 respectively, according to Huawei’s tests.

Also debuting in the new Kirin chipset is the Mali G76 GPU, which should offer 30 percent more efficiency and let devices run a wider variety of high-end games. Then, there’s the 1.4Gbps Cat 21 LTE modem, which should offer faster cellular data transfers, and new support for 2,133MHz LPDDR4X RAM should enable speedier multitasking. The Kirin 980 will also be compatible with Huawei’s Balong 5G modem in preparation for next-gen networks, and packs dual image signal processors that promise better photo quality.

The chipset is set for commercial availability on Huawei devices for consumers before 2018 ends. Compared to the previous generation 10nm process, the 7nm process packs 6.9 billion transistors in the same form factor as its predecessor, while delivering 20% improved performance and 40% more efficiency.

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