Mobile Technologies Index
Application processors: Driving the next wave of innovation

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Application processor speed is improving so fast that by the time you finish reading this article, it is likely to have made another leap forward and triggered a new wave of mobile innovation.

While that's an exaggeration, it is not an exaggeration to expect application processors' clock speeds to increase from 1Gigahertz (GHz) to 1.5GHz and beyond in 2012. This is important because a jump of this magnitude has historically marked the beginning of the next cycle of processor-driven innovation for mobile devices, as explored later in this article and illustrated in Figure 2.

PwC forecasts a compound annual growth rate (CAGR) of 53 percent for application processor speed, as measured by Gigahertz per core per dollar (GHz/Core/$), through 2015 [see Figure 1], a faster growth rate than the 43 percent CAGR for 2007-2011. Stated another way, by the end of our forecast period, application processor speed will have increased five times from what it was in 2011, our baseline year. The CAGR for application processors will grow faster than the CAGR for any other device component of the ***Mobile Technologies Index***, and second only to the ***infrastructure speed component*** (54 percent CAGR).

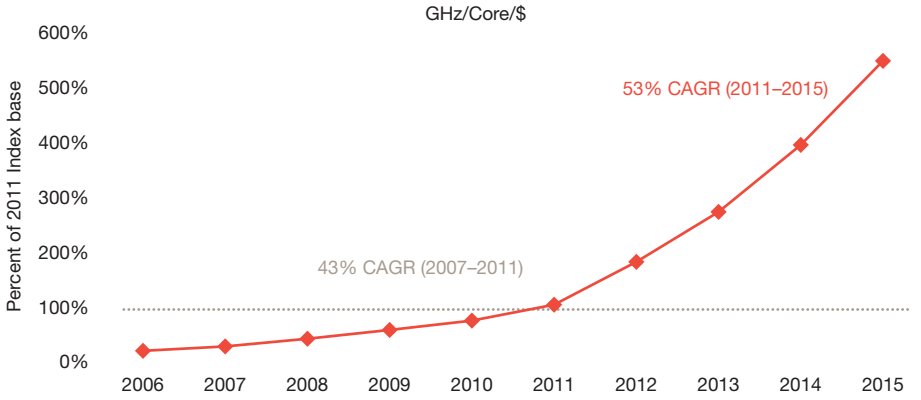
This essentially means that the application processor, which is equivalent to a personal computer's central processing unit (CPU) and is also known as the mobile processor, will enable various mobile device use cases, likely to include more powerful multitasking operating systems, more immersive and natural user interfaces and more powerful graphics, including 3D. Many vendors are already designing and building these because they can be sure that the processor will be up to the tasks.

We define processing power as an amalgam of the maximum clock rate per core with which a mobile device can perform tasks and run applications. In smartphones and other mobile devices, application processors have evolved from single core 300-400MHz chips to dual core 1.2 to 1.5GHz chips and are on the road to quad core 1.5GHz and beyond. Several tablets already have 1.66GHz processors.

To understand the importance of the application processor to mobile innovation, consider the user interface. The original 2G iPhone, launched in 2007, was the first smart phone of its type to allow for a multi-touch user interface. And this was around the same time that the GHz/Core/$ metric allowed application processor chips to surpass the 500MHz threshold.

The earlier application processors used by smart phones were more commonly in the 200 MHz to 400MHz range and limited operating systems to point and click interfaces using trackballs, wheels or styli as well as single-touch capability.

Figure 1: Applications processor, compound annual growth rate (CAGR)



Source: IHS iSuppli Mobile and Wireless Communications Service

The advent of multi-touch spawned a wave of innovation aimed at more natural user behaviour when flipping and viewing pictures and pages or for other tasks. The user interface of a smart phone is now more similar to the hand gesture user behaviour for the same tasks in the physical world—with all the "intuitiveness" that implies—and a big driver of the mass adoption of these devices.

Another example later in the smart phone evolution is that of multi-tasking operating systems. As the smart phone evolved from a personal information device into a full-fledged mobile computing platform, consumers expected to be able to work on and share data between multiple applications concurrently as they do on a PC, pulling operating system requirements in that direction.

However, it wasn't until 2009-2010 when the GHz/Core/$ metric enabled mobile devices to reach the 1GHz threshold that this type of operating system became viable and able to be fielded in such a way that did not bog down the device to the point of rendering it unusable.

Limitations to overcome

Although mobile processing power has begun to approach personal computer processing power, smart phones and tablets have constraints that suggest full equivalence with the PC may be well beyond our forecast period. As gigahertz increase in the smart phone, two problems arise: power limitations and overheating.

Since we only expect incremental improvements in battery life and power management during our forecast period, something will need to be done to allow multi-core processors to operate without quickly draining the battery. And given the tiny footprint of the processor in handheld devices, plus the lack of a fan, the heat dissipation problem could become acute. A user won't get much use from all the cores if the device itself is too hot to hold.

The industry move to the 28 nanometer silicon process node in chip manufacturing could help, but chipmakers are also working on other solutions. In standard multicore architectures as seen on desktop computers, the processing for any job is typically spread among undifferentiated cores, which heats up everything and is not always the most efficient use of power.

In mobile, one approach could be "smart multicore," in which individual cores are specialised for a particular processing requirement—say video—thereby reducing power drain and heat generation. In other words, cores could be power-optimised for the specific job. A variation on this is a separate adjunct chip for a specific computing task. In other words, in the context of future mobile devices all gigahertz may not be created equal. We will track this evolution, and depending how it goes, we might need to rethink the composition of the application processor metric in the Mobile Technology Index.

Whatever the ultimate architecture of future application processors, they will become more powerful and this will allow OEMs to create devices with new capabilities, or entirely new devices or platforms, which in turn are critical to triggering the next big success.

Immersive interfaces

Enabling more immersive and natural user interfaces and experiences is one of the opportunities for creating an environment in which the next explosion can occur. Features such as 3D, gesture control and devices that process and act upon real world stimuli will be among the next evolutionary steps on this path, and will demand faster processors.

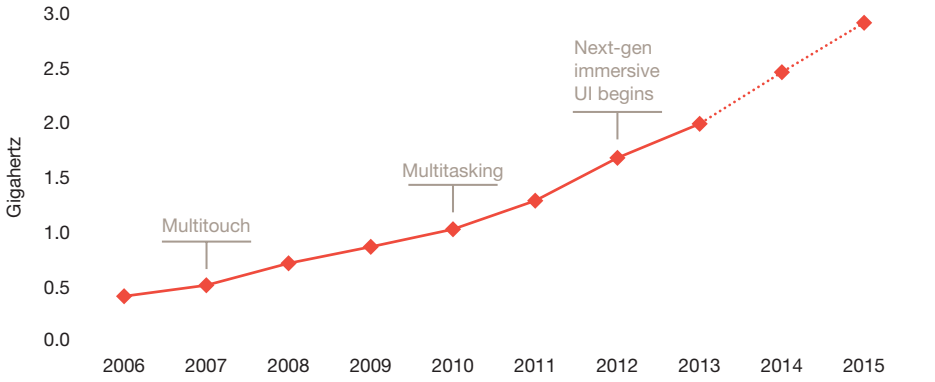
A new use case just beginning to take advantage of greater processor power is the ability to stream content wirelessly from a smartphone or tablet to a TV set or computer screen. Apple has launched AirPlay technology for content streaming among its products but not outside its ecosystem. For everyone else, OEMs are beginning to certify products on the Miracast standard, with some expected in stores for the holiday season. AirPlay and Miracast are based on newer versions of Wi-Fi (to be explored in a future article). In this content streaming use case, the application processor in the handheld is the pump that pushes the bits to the TV screen.

As this content model advances, more powerful processors will play another crucial role. Most of us quickly learn to operate our TV remote controls based on the tactile feeling of the buttons while our eyes continue to watch the screen. As a remote control, the smartphone has virtual buttons, which users have to look at. Within our five-year forecast period, we expect a solution: new technology (to be explored in a future article) that senses where your fingers are hovering over the screen and projects an icon on the TV screen for the button you are above—channel changer or volume control, for instance. The sensing technology and software that will make this possible will require the level of processing power we are forecasting in future processors.

We anticipate the 1.66GHz threshold, which application processors will soon reach in large numbers, to be the launching point for the next cycle of innovation. [See Figure 2] It is important to keep in mind that not all of the next evolutionary steps will occur at the same time, but that this processor threshold is the starting point for some of these to begin to become viable in technology and cost.

In our forecast, the GHz/Core/$ metric enables devices to exceed this 1.66GHz threshold in large numbers in 2013-2014, and to approach the 3GHz threshold in 2015-2016. There is already at least one 2GHz smartphone that will be sold in markets outside North America before the end of 2012. Higher performing application processors at ever-declining prices will drive higher levels of smart handheld device penetration compared to feature phones, producing a larger total market.

Figure 2: Cycles of processor-driven innovation



Source: IHS iSuppli Mobile and Wireless Communications Service

The industry will continue to push beyond the 1.66GHz threshold in application processors in 2013. But how far beyond depends on factors not currently predictable. The possibility of 3GHz exists—PC processors have gone there. But power and heat problems for mobile devices at that clock speed are creating huge challenges for chip designers. Moore's Law is silent on these issues.

As noted above, gigahertz increases in the smart phone are challenged by power limitations and heat dissipation problems that must be solved. While a 3GHz mobile processor is possible (at least one prototype exists), how the industry will surmount these physical hurdles is not clear.

"Even desktop processors have gotten out of the gigahertz race to some degree, delivering more cores and relying on parallelism to crank out more power rather than ever-faster clock speeds," says Chris Richard, PwC Management Consultant Lead, Semiconductor Practice. "Consumers will use all the gigahertz vendors can throw at them, but beyond 2015 it remains to be seen what scientists and engineers will be available to deliver."

Chris Richard
PwC Management Consultant Lead, Semiconductor Practice

Let's talk

If you have any questions about the Mobile Innovations Forecast or would like to discuss any of these topics further, please reach out to us.

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