Mobile Processor Architectures: Design Implications and Challenges for Energy Efficiency

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Over the past decade, mobile devices evolved from feature phones used solely for making voice calls to smartphones that can provide a rich end-user experience on the go. Modern day mobile device design is driven by exceedingly ambitious user experience requirements. Each generation is expected to compute faster, last longer, and accommodate more peripherals into increasingly thin form factors. In fact, users expect mobile devices to deliver desktop-level performance while adhering to strict battery-induced energy constraints and all-day compute requirements.

In order to achieve desktop-level performance, mobile processors over the years have adopted many high-power mechanisms found in the desktop processor ecosystem. Frequency increases, aggressive microarchitectures, and multicore scaling allow mobile processors to minimize response latencies and provide higher throughput across a breadth of applications. While these techniques fostered performance improvements, they make mobile processors an outstanding source of power consumption among other smartphone components. An important recent observation challenges the conventional belief that display and radio consume more power than the processor. Figure 1 shows the peak sustainable power for the display, cellular radio, and processor subsystem across five generations of mobile devices. We observe an inflection point in 2011 where the processor began overtaking the display as the worst-case power consumer.

Prior energy-efficient mobile device research focused on optimizing the display, radio, and processor, in that order. Given the sharp increase in processor power consumption over the recent years, it is time to revisit the status quo. There is a strong need to focus on mobile processor energy-efficiency research. Designers must understand how mobile application requirements and strong user-driven performance requirements have led to the processor's evolution and its emergence as the dominant power consumer. On the basis of examining existing and off-the-shelf smartphones that represent five years of cutting-edge mobile device technology, we will discuss future design challenges for mobile device energy efficiency. The talk raises a fundamental question of whether future mobile devices will be able to deliver desktop-level performance with only marginal increases in smartphone battery capacity and density.

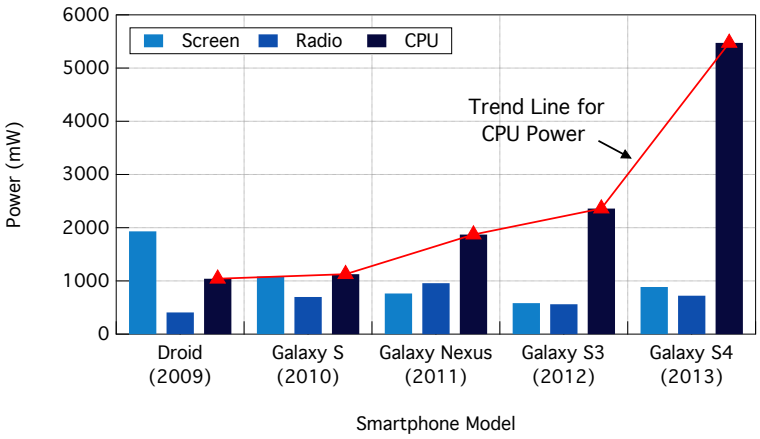

Figure 1: Peak power consumption across major smartphone components over the course of five smartphone generations.