What's So Special about the Digital Signal Processor?

DEC 5, 2013

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Short answer: It's an essential processing engine for mobile heterogeneous computing.

As discussed in my previous blog, the fundamental premise of heterogeneous computing is that running the appropriate task on the most suitable processing engine delivers performance and power benefits. I've described how having the right specialized processing engines, namely the CPU, GPU, and DSP, in the system-on-a-chip is key since it delivers the best user experience. So why is the DSP in particular so important? In a recent webinar, Qualcomm Technologies took a deep dive into DSPs and looked at the role they play in mobile heterogeneous computing. Here are my key takeaways.

The DSP plays a key role in mobile heterogeneous computing. New applications offer breakthrough experiences and increase our engagement with our mobile devices. Many of these experiences—such as sound and image enhancements as well as advanced camera and sensor capabilities—include signal-processing tasks that the DSP excels in executing at

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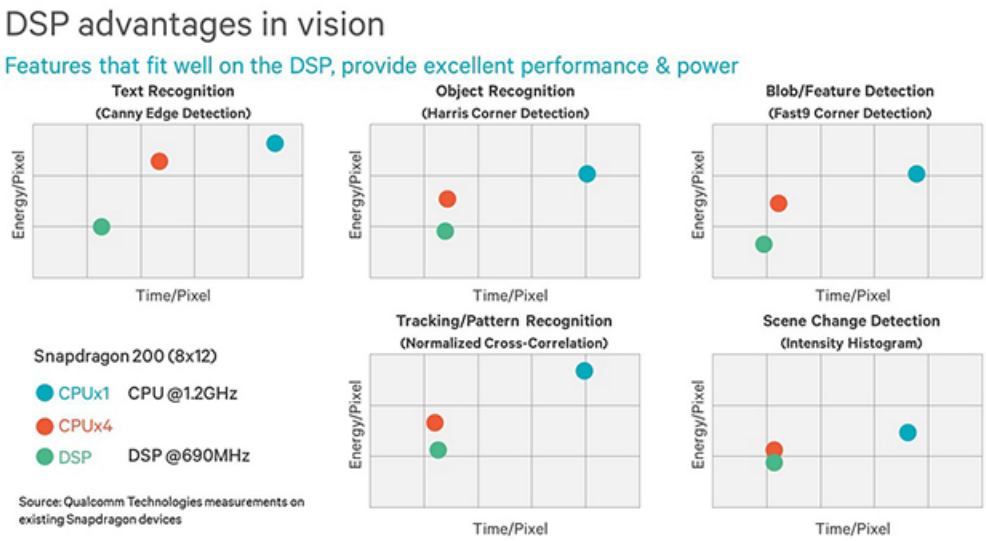
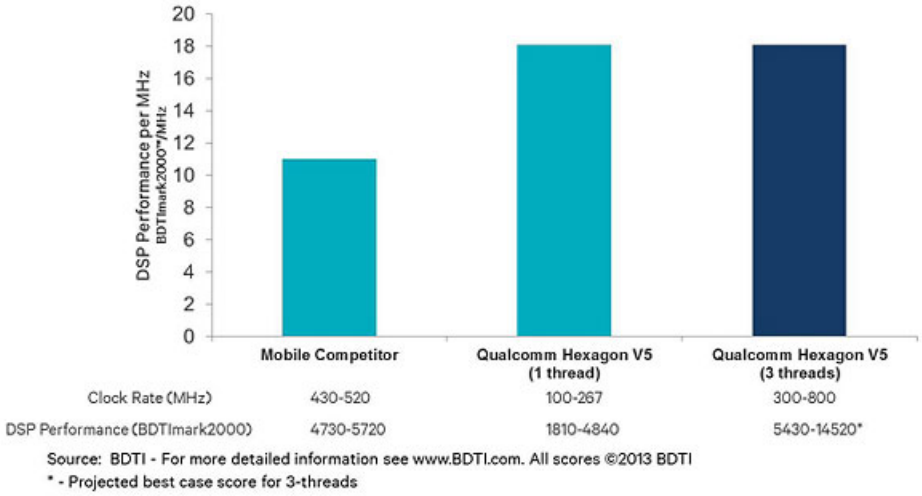
A DSP architecture has unique benefits and is different from CPU and GPU architectures. As highlighted in the webinar, DSPs have a fundamentally different architecture than a CPU or GPU. As a result of the architectural decisions, DSPs have two key attributes:

- **DSPs maximize work per clock cycle**. DSPs are designed to execute complex math in parallel, which is common in many signal processing applications. For example, the Hexagon DSP is able to execute the main Fast Fourier Transform (FFT) loop, which is 29 "simple reduced instruction set computing (RISC) operations," in one clock cycle. By having hardware and an instruction set architecture (ISA) optimally designed for the FFT, the FFT is executed with higher performance in shorter time—and at lower energy.
- **DSPs deliver high performance at lower clock frequencies, which saves power**. Power is directly proportional to the clock frequency and voltage squared. To run the clock at a higher frequency requires a higher voltage, which leads to an exponential increase in power draw. For example, the Hexagon DSP is able to run at low clock frequencies while delivering high performance through hardware multi-threading, and by maximizing work per clock cycle.

Because of its unique architecture, the DSP has different strengths, which allow it to excel at different tasks. With the introduction of cameras and high-resolution displays, many new "vision" tasks have emerged. Many of these vision tasks run at higher performance and lower power on a DSP compared to running on a single-core or quad-core CPU, as seen in the following charts.



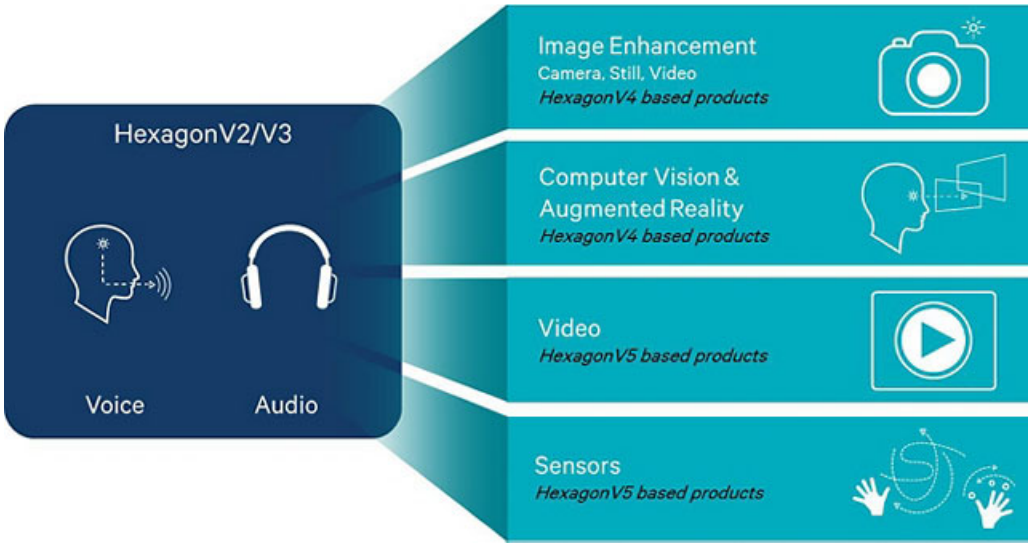
Not all DSPs are created equal. The Hexagon DSP from Qualcomm Technologies has an efficient mobile architecture that delivers the most performance per MHz. Looking at the benchmarking results from BDTI, the Hexagon DSP beats its most relevant mobile competitor.



The DSP architecture efficiently delivers the most performance per MHz because Qualcomm Technologies controls the Hexagon DSP ISA and custom designs the DSP specifically for mobile. This allows Qualcomm Technologies to:

- Carefully balance the DSP with the rest of the custom designed processing engines in the overall Snapdragon processor, leading to smart integration.

The Hexagon DSP enables rich user experiences. The Hexagon DSP started as a processing engine primarily used for voice and simple audio playback. The Hexagon DSP has expanded its role and is now used for a variety of use cases, such as image enhancement, computer vision, augmented reality, video processing, and sensor processing.



Now you know why DSPs are so important. The Hexagon DSP goes a step further with a unique architecture that allows it to offer the required performance for emerging mobile experiences at low power. Be sure to check out the webinar for many more details.

Want to learn more? Look for future blogs and webinars to learn about Qualcomm's view on mobile heterogeneous computing.

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