Measuring the Gap between FPGAs and ASICs
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Everyone understands that programmability has a cost. This paper is one of the most cited papers in this collection because it quantifies the cost of programmability. The abstract claims the core area for an FPGA is, on average, a surprising 40 times higher than a standard cell ASIC and is motivational to all work improving FPGA architectures and structured ASICs.

Prior to this paper, most comparisons were anecdotal characterization of small circuits and tended to only compare FPGAs with mask-programmable gate arrays, suggesting only a 10× area penalty. However, by 2006, ASIC CAD had improved and synthesized standard cell designs were the more common choice for ASIC implementations.

In defense of the FPGA architects of the world, the highly-cited 40× result is exaggerated, because it considers only core area, and is obtained by considering designs with both logic and arithmetic in an FPGA architecture lacking hardened multipliers. This paper breaks down the benchmark suite into four classes based on whether they contain arithmetic or memory in addition to unstructured logic and registers. In the class containing logic and arithmetic, the FPGA architecture that includes hardened multipliers has an area ratio of 28 versus the ASIC.

Perhaps the more enduring contribution of this paper is the demonstration of the correlation between benchmark results and FPGA architecture features like memories and DSPs. The contribution of hardened components to optimizing cost and performance cannot be ignored. In modern FPGAs, the decisions about what components to harden and how are as important as the traditional FPGA architecture questions like LUT size and interconnect topology.

Benchmarking papers like this are always controversial because they either make imperfect comparisons between different quantities or they use abstractions that make the comparisons more equivalent but less meaningful. This paper does an exemplary job of making the comparisons, and describing in detail exactly how those comparisons are made to allow the readers to form their own conclusions from the results.

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