

UD Computational Science Day 2006

February 14, 2006

Accelerated Modeling and Simulation with a Desktop Supercomputer

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Abstract

The performance of modeling and simulation tools is inherently tied to the platform on which they are implemented. In most cases, this platform is a microprocessor, either in a desktop PC, PC cluster, or supercomputer. Microprocessors are used because of their familiarity to developers, not necessarily their applicability to the problems of interest. We have developed the underlying techniques and technologies to produce supercomputer performance from a standard desktop workstation for modeling and simulation applications. This is accomplished through the combined use of graphics processing units (GPUs), field-programmable gate arrays (FPGAs), and standard microprocessors. Each of these platforms has unique strengths and weaknesses but, when used in concert, can rival the computational power of high-performance computing (HPC) solutions. By adding a powerful GPU and our custom designed FPGA card to a commodity desktop PC, we have created simulation tools capable of replacing massive computer clusters with a single workstation. We have targeted a variety of applications for this platform ranging from computational electromagnetics and linear algebra to image processing and synthetic aperture radar analysis. Benchmarks of our initial solvers have shown that we can rival the speed of a 150-node PC cluster from a single workstation. We are currently extending the underlying platform and applying it to new applications.