Performance of a Stream Processing Model on the Cell BE NUMA Architecture Applied to a 3D Conjugate Gradient Poisson Solver

Vincent Heuveline¹, Dimitar Lukarski²*, Jan-Philipp Weiss²

¹ Numerical Simulation, Optimization and High Performance Computing
² SRG New Frontiers in High Performance Computing
Karlsruhe Institute of Technology, Universität Karlsruhe (TH), Germany
{vincent.heuveline, dimitar.lukarski, jan-philipp.weiss}@kit.edu

Abstract. The STI Cell Broadband Engine is a highly capable heterogeneous multicore processor with huge bandwidth and outstanding computing power perfectly suited for numerical simulation. However, all performance benefits come at the price of productivity since more responsibility is put to the programmer. As an alternative programming approach, stream processing models with easy learning curves, single-threaded programming manner, and conceptually excluded data conflicts can be applied. But despite of corresponding benefits in productivity some algorithmic features and methodologies like temporal blocking cannot be expressed meaningfully due to model-intrinsic constraints.

In the present work we investigate the performance behavior of a resource-demanding and bandwidth-bound three-dimensional fluid dynamic application on the Cell processor. The RapidMind Development Platform is used to map the projection step of a Chorin-based Navier-Stokes solver to Cell’s parallel cores. Particular care is taken of NUMA effects on IBM BladeCenter QS21 systems. Our results show that the stream processing model can be applied efficiently. Main memory bandwidth utilization remains a performance-critical issue.

Keywords: Cell BE, RapidMind, Navier-Stokes solver, Poisson solver, conjugate gradient, bandwidth-bound algorithm, stencil kernel, IBM BladeCenter QS21, NUMA.

* Corresponding Author. Email: dimitar.lukarski@kit.edu.