We applied nested OpenMP parallelization to a Geothermal Simulation Code to efficiently exploit ScaleMP’s vSMP architecture, which couples commodity x86-based boards via InfiniBand to run a single system image.

The Institute for Applied Geophysics – E.ON Energy Research Center at RWTH Aachen University is currently developing the SHEMA-T-Suite, a new program package for geothermal simulation. It solves the coupled transient equations for groundwater flow, heat transport, and the transport of reactive solutes in the porous media in three space dimensions. The parallelization aims at the two most time- and memory-intensive parts of the program, namely the assembly of the coefficient matrices and the solution of the corresponding large linear systems of equations, using OpenMP on two levels. The ScaleMP architecture provides a cache-coherent aggregation of commodity dual-socket boards via an InfiniBand network by employing a virtualization layer on each node to run a single Linux image.

Offering the look and feel of a normal SMP, our performance measurements disclosed significant cc-NUMA characteristics. With nested parallelization, special care has to be taken in order to place the threads of the inner team close to their data and to maintain persistence across consecutive executions of the inner parallel region. We therefore developed a library to automatically bind nested OpenMP programs to a hierarchical system architecture according to a specified strategy. Selecting the optimal strategy is subject to ongoing research.

Using the SHEMA-T-Suite with 16 threads scheduled on four ScaleMP nodes, this system outperforms both a 16-way Intel Tigerton system and a 16-way AMD Opteron system. Profiting from the accumulated total main memory size and bandwidth with an increasing node count, we achieved a speedup of 12.5 employing 40 cores.

Shemat-Suite: Geothermal simulation package for simulating groundwater flow, heat transfer and transport of reactive solutes.

Redevelopment and enhancement with Inversion and Parallelization in a new simulation package SHEMA-T-Suite.

ScaleMP: Cache-coherent aggregation of commodity nodes via InfiniBand to run a single Linux system

INSTITUTE FOR APPLIED GEOPHYSICS – E.ON ENERGY RESEARCH CENTER
geophysik.rwth-aachen.de

INSTITUTE FOR SCIENTIFIC COMPUTING
sc.rwth-aachen.de

CENTER FOR COMPUTING AND COMMUNICATION
rz.rwth-aachen.de

Example for a sedimental model
as employed in the SHEMAT-Suite