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High performance geo-computing with commodity architecture

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Modern 64-bit, shared memory, multiprocessor architectures become more and more a commodity and are increasingly used in scientific computing. This new architectures make substantially more memory (RAM) directly available to the user. Fast access to huge amount of memory makes it possible to efficiently solve problems of sizes previously unachievable, or requiring very expensive clusters/supercomputers. We investigate the suitability of a cheap supercomputer equipped with AMD Opteron CPUs and 128GB of RAM for regularly encountered computational challenges in modelling of geological processes. First, we solve a standard parabolic problem, 3D diffusion equation with both Dirichlet and Neuman boundary conditions, using unconditionally stable, ADI (Alternating Directions Implicit) method, Douglas-Gunn scheme. Next, we use the ADI method to solve hyperbolic problems - 3D wave equation. Both solutions are analyzed for domains including strong material heterogeneities, which is of great relevance to problems commonly found in geology. We present efficiency results for both sequential and parallel runs of our code. Exploitation of fine-grain parallelism through vectorization of floating-point operations allows us to achieve sequential performance of over one GFLOPS for problems reaching 2000ˆ3 grid points on a single CPU. This implies that a single time step of such a large problem can be solved in approximately one minute. Utilizing NUMA (Non-Uniform MemoryArchitecture) and symmetric multiprocessing for coarse-grain parallelism yields a scalable parallel algorithm.