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Modern Hardware Solutions to Speed Up Tsunami Simulation Codes

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Protection of coastal areas from a disaster tsunami waves is based on the warning system. The warning system describes tsunami phenomena to predict wave parameters and inundation zones. The sooner the correct prediction is given the better is the protection provided. Modern algorithms are able to process data in real time when using advanced hardware architectures. The authors of the paper present results that compare several hardware solutions for tsunami simulation.

The following parts of tsunami warning system are considered: monitoring of tsunamigenic zones for precursors (or foreshocks) analysis; tsunami wave propagation over the deep water; inundation of dry land. The authors suggest to improve performance of the warning system by applying modern computer systems, such as clusters with distributed memory and joint memory; Graphics Processing Units (GPU), IBM CELL BE based solutions.

Software for energy precursors (or foreshocks) analysis has been developed for the source zones monitoring [1,2]. Parallelization at any available platform gives perfect scalability. GPU based solutions enable to achieve the best performance of approximation of the wave profile by linear combination of the unit sources signals. Calculating inundation zones best performance is accomplished with IBM CELL BE processors or multi processor cluster systems.

Simulation of tsunami wave propagation over the deep water is one of the most time consuming tasks of the warning system. The authors utilize Method of Splitting Tsunami (MOST) package, accepted by the National Ocean Atmospheric Administration (NOAA), USA. The software generates calculation of wave propagation at deep water by splitting along coordinate axis. Nonlinear shallow water system is used as the governing equations. Some tasks of the algorithm could be executed in parallel mode, however, direct application of multi processor systems results only in two times performance gain. After a number of optimizations, the authors achieved 16 times performance gain. OpenMP technology was applied. When utilizing Sony PlayStation3 platform (IBM CELL BE architecture) 60 times code acceleration was accomplished. The best result was achieved with modern GPU (GForce 8800 and TESLA), 100 times performance gain.

Direct application of the MOST source code to any of the above platforms does not give desirable results. To obtain the best performance joint expertise of specialists in parallel methods on modern hardware architectures and geophysics is needed.

1. M.M. Lavrentiev, Jr., K.V. Simonov, V.G. Sibgatulin, S.A. Peretokin Evaluation of geodynamic risks for Krasnoyarsk territory // Proc. International Conference in occasion of 60 years of Kait Earthquake of 1949 in Tadzhikistan, Dushanbe, July 11-19, 2009, pp. 251-268.

2. M.M. Lavrentiev, Jr., K.V. Simonov Energy-Based Analysis of Tsunamigenic Earthquake Prediction // 24th International Tsunami Symposium, Programme and Abstracts, July 14-17, 2009, Novosibirsk, Russia, p. 75.