AAPG Datapages/Search and Discovery Article #90255 © 2016 AAPG/SEG International Conference & Exhibition, Barcelona, Spain, April 3-6, 2016

Optimization Strategies for Implementing Elastic Wave Propagators in Intel Xeon Phi Coprocessors

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Abstract

Acoustic wave propagation has been the preferred engine for geophysical exploration applications for the last few years due to the large cost involved in using better approximations, especially for 3D full-wave field modeling-based applications. Hence, simplified approaches have been used to generate images of the subsurface so that data processing can be finished in a reasonable time. The current trend in seismic imaging aims at using an improved physical model, considering that the Earth is not rigid but an elastic body. This new model takes simulations closer to the real physics of the problem, at the cost of raising the needed computational resources. Moreover, to take the simulation representation a step closer to the real physics, some kind of anisotropy in the propagation medium should be considered. However, this againmay rice the computational cost of the simulation.

On the hardware front, recently developed high-performing devices, called accelerators or co-processors, have shown that can outperform their general purpose counterparts by orders of magnitude in terms of performance per watt. These new alternatives may then provide the necessary resources for making possible to represent complex wave physics in a reasonable time. There might be, however, a penalty associated to the usage of such devices, as some portion of the simulation code might need some re-writing or new optimization strategies explored and applied.

We have designed and implemented a complete suite of wave propagators, which includes an elastic one for fully anisotropic scenarios using a Finite Differences (FD) method over a Fully Staggered Grid (FSG). In this work we will show that regarding the computational cost and complexity of this application it is possible to outperform contemporary regular processors. We will expose some optimization strategies evaluated and applied to an elastic propagator based on a Fully Staggered Grid, running on the Intel Xeon Phi coprocessor. The evaluated set of optimizations ranges from memory to compute optimizations. Our results show that it is possible to obtain more than an order of magnitude of improvement when comparing the fully optimized code with a na iuml; ve version, while up to a 7x of improvement is possible with little investment on code optimization. It is important to remark that the propagator is able to reproduce elastic wave propagation, even for an arbitrary anisotropy.