

Towards an Efficient and Reliable HPC Software Platform for 3D Geophysical Inversion

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Abstract

The inversion process is one of the most important and complex processes in subsurface exploration. Even if usually the theoretical methods are well known and prototyping is not a painful issue, the reality is that the oil and gas industry requires a huge amount of computational resources to solve those problems. Therefore, software able to manage and provide enough capabilities to deal with 3D inversion in a High Performance Computing (HPC) environment is of outmost importance. Furthermore, defining specific software for each process such as Full Waveform Inversion (FWI) or Electromagnetic Inversion (EMI) independently is too costly and the maintenance and porting of such codes unaffordable. Furthermore, the upcoming joint inversion algorithms will need similarly capable seismic and EM inversion tools.

In this work we propose using two software frameworks that provide HPC developers with tools oriented towards efficiency and resiliency, respectively. The efficiency-oriented framework automatically provides the developer with parallel strategies, such as domain decomposition or asynchronous disk I/O so that the developer can concentrate on writing the algorithm specific to the problem at hand. At the same time, the framework structure simplifies the portability of the code to different HPC architectures. On the other hand, the resiliency-oriented framework provides the developer with the means to launch parallel applications in a distributed environment with full support to fault tolerance.

As an example, we show a whole geophysical imaging system called BSIT, which is built upon the usage of such frameworks and some additional supporting modules. In particular, BSIT's wave propagation libraries have been developed using the efficiency-oriented framework and ported to many HPC platforms and its master-worker parallelism and distributed workflows have been built using the resiliency-oriented framework and are able to sustain large workflow tasks in a robust and scalable way.