MP-FWI Imaging and Green HPC: The Future of Processing and Imaging

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Abstract

Introduction
As the energy transition unfolds the oil and gas industry must strive to reduce the environmental impact of the exploration and development of hydrocarbons. De-risking prospects is a vital aspect of this given the carbon and monetary cost of drilling a well. Recent advances in full waveform inversion (FWI) have delivered a step change in the quality of seismic images for interpretation allowing for improved decision-making.

Multi-parameter FWI (MP-FWI) imaging is one such technology that is able to simultaneously determine a high- resolution velocity model and true-amplitude reflectivity model using the full wavefield, directly from the field data. The increased computational demand of this approach requires significant high-performance computing (HPC) capabilities which usually come with an associated carbon footprint. However, the use of a novel immersion-cooled HPC solution, which drastically reduces energy consumption, combined with renewable sources of power means that environmental impacts can be minimised.

MP-FWI imaging
Traditional seismic processing workflows can be extremely time-consuming since subsequent stages only begin after extensive testing and QC of the current process. This serial approach takes the raw field data and passes it through a plethora of conditioning tools to transform the data into a form that legacy migration algorithms can image.

MP-FWI imaging is a novel approach to seismic processing and imaging that uses the full wavefield to simultaneously determine a variety of earth parameters, including velocity and reflectivity, using minimally processed field data. With this technology, the conventional processing workflow is not required since the algorithm can utilise aspects of the wavefield that have traditionally required attenuation before imaging such as ghost and multiple energy. Imaging using the full-wavefield provides greater sampling of the sub-surface leading to improved illumination and resolution of key targets compared to legacy imaging products.

Green HPC
The iterative, multi-scale nature of full waveform inversion comes with an increase in computational demand compared to the conventional processing and imaging workflow. That demand scales with frequency to the fourth power meaning that an inversion at 100 Hz requires almost 5000 times more compute than at 12 Hz, which is typical for velocity model building.

Running high-frequency FWI in a rapid, cost-effective manner requires substantial HPC resources. Mitigating the environmental impact of such a large computational demand requires efficient data centres powered by renewable energy. Our custom-built data centres completely immerse standard servers in a non-flammable, non- conductive dielectric fluid. The thermal efficiency of the fluid means the hardware can be cooled by a warm water loop and with no chillers or fans, power usage is cut by up to 51% compared to a conventional air-cooled data centre. This combination of efficient HPC powered by renewable energy greatly reduces the carbon footprint of processing and imaging projects including MP-FWI imaging.

Conclusion

Efficient, low-carbon HPC and MP-FWI imaging can provide superior results to the conventional workflow in a reduced timeframe while mitigating the carbon footprint. These high-resolution outputs enable improved and more flexible decision-making which can drive efficiency and reduce the environmental impact of the oil and gas industry.