OPESCI: Open Performance portablE Seismic Imaging

Marcos de Aguiar
SENAI CIMATEC
Av. Orlando Gomes 1845
Salvador, Bahia, Brazil
marcos.aguiar@fieb.org.br

Gerard Gorman
Imperial College of London
R4.92 Royal School of Mining
London, United Kingdom
g.gorman@imperial.ac.uk

Renato Miceli
SENAI CIMATEC
Av. Orlando Gomes 1845
Salvador, Bahia, Brazil
renato.miceli@fieb.org.br

Christian Jacobs
Imperial College of London
R4.92 Royal School of Mining
London, United Kingdom
c.jacobs10@imperial.ac.uk

Michael Lange
Imperial College of London
R4.92 Royal School of Mining
London, United Kingdom
michael.lange@imperial.ac.uk

Tianjiao Sun
Imperial College of London
R4.92 Royal School of Mining
London, United Kingdom
tianjiao.sun14@imperial.ac.uk

Felippe Zacarias
SENAI CIMATEC
Av. Orlando Gomes 1845
Salvador, Bahia, Brazil
felippe.vieira@fieb.org.br

ABSTRACT

While O&G revenues are huge, high costs of data acquisition, drilling and production, reduces profit margins to less than 10%. Subsurface imaging techniques reduce the need for expensive exploratory drilling and enable reservoir monitoring throughout their life cycle to help maximize the value of discovered resources.

However, seismic wave inversion is computationally demanding and only because of recent advancements in High-Performance Computing (HPC) 3D Full Waveform Inversion (FWI) has become feasible. This challenge is compounded by the quantity of seismic data collected out pacing our ability to use all available information to create accurate subsurface images.

Entering the exascale era, HPC architectures are rapidly changing and diversifying so to continue delivering performance increases within tight energy envelopes. These disruptive changes offer opportunities while also demanding disruptive software changes to harness the full hardware potential. The question is how to achieve an acceptable degree of performance portability across different, rapidly evolving architectures, in spite of the sharp trade-off between easy-to-maintain, extensible portable software written in high-level languages; and highly optimized, parallel codes for target architectures.

The solution proposed is to leverage domain-specific languages (DSL), compilers and code generators to introduce multiple layers of software abstraction. At the highest level of abstraction application developers write algorithms in clear, concise manner akin to how algorithms are written mathematically, while at the lower levels source-to-source compilers explore rich implementation spaces to transform DSL codes into highly optimized native codes that can be compiled for target platforms for near-to-peak performance. The framework provides layers, decoupling domain experts from code tuning specialists, where different optimized code generator back ends can be replaced. This separation of concerns enables performance portability, enhanced programmability and productivity, and the capacity to readily evaluate at high level whether new numerical approaches or inversion algorithms match or outperform hand-tuned code without implementation or maintenance overhead.

1. REFERENCES

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