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Optimizing Geophysical Processing: Petrobras' Strategic Response to Evolving HPC Trends

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Introduction

The market for High-Performance Computing (HPC) has been giving signs of paradigm shifts, driven by the rapid growth of artificial intelligence and the evolution of the commercial cloud environment. These transformations not only create new opportunities for geophysical processing but also present significant challenges, especially considering the complex architecture required for adaptation to cloud environments and performance portability. Additionally, Petrobras faces challenges such as possible import restrictions on chips that could represent a critical barrier to the technological options available to the company, necessitating an even more robust and diversified strategy.

Method and/or Theory

In addition to commercial solutions, Petrobras develops its own specialized software to perform geophysical processing in supercomputers. Traditionally, these algorithms have been constructed with relatively simple code bases, employing programming languages such as Fortran90 and C. However, this code relies heavily on complex optimization strategies, such as OpenMP, MPI, and CUDA, to maximize performance.

In recent years, Petrobras has been engaged in modernizing and adapting its code base to make it more flexible and responsive to recent and possible imminent changes in the HPC market. However, this modernization has been carried out in a fragmented manner, responding to specific demands from each project, which resulted in challenges for effectively prioritizing these improvements in alignment with Petrobras's strategic goals.

Results and Conclusions

In response to this challenging scenario, our Geophysical Technology department established a scientific computing architecture group with the mission of promoting structural changes and a more strategic and coordinated approach to the technological initiatives that aren't directly tied to geophysics and research.

This group operates collaboratively, respecting existing project teams without replacing them or imposing rigid standards. Instead, it focuses on identifying common challenges faced by different projects, fostering open discussions about solutions, and promoting transformations that will make Petrobras more resilient to fluctuations in the HPC market.

The initial results of the scientific computing architecture group's activities within Petrobras are promising and encompass a range of significant initiatives, such as conducting systematic HPC benchmarks, adapting the codebase and its frameworks for cloud environments, redefining transit time table formats, and promoting interoperability of data and processes among commercial software and our internal solutions.

The approach adopted by this group has proven to be an effective strategy for enhancing Petrobras's capabilities, preparing it more robustly to face future challenges in the geophysical computing sector and ensuring that Petrobras remains competitive in a rapidly changing market. The continuation of these initiatives will be crucial to ensure that Petrobras not only adapts but also thrives in an ever-evolving technological landscape.