Adaptive Programming of Parallel, Hybrid Architectures

In this talk, I will present the part of the work developed at the Group of Parallel and Distributed Programming (GPPD), of the Federal Univ. of Rio Grande do Sul (Porto Alegre, Brazil), that is dedicated to parallel programming.

The current parallel HPC applications are composed of hundreds of thousands of tasks running on distributed memory architectures (clusters), each node being itself parallel – typically multi-core. On one hand, the way these tasks should be described by the programmer is not clear. The standard APIs – MPI, OpenMP – have limited capacities to support frequent high-level constructs such as pointer-based data-structures, recursive algorithms or irregular computations; all kinds of characteristics which turn to be important when the program has to adapt, at runtime, to variations of its environment (e.g. the load, or the availability of some cores). On the other hand, the continuously evolving architecture requires each time more adaptability from the parallel program. It is the case, for instance, of the power-saving chips, or of the increasing trend towards using CPU based clusters together with GPUs or other non general-purpose devices (hybrid architectures).

I will present a few contributions to improve the adaptability of HPC parallel programs in this context:

- the improvement of the scheduling of dynamically created processes in MPI (PhD of Marcia Cera, Master thesis of Stefano Mor),
- the transparent use of threads and processes to implement, at runtime, the dynamic tasks spawned by MPI (master thesis of João Lima),
- the use of a non-standard API, called Kaapi, to abstract the notion of task in Containers, and thus facilitate the programming of hybrid machines (joint work with the French laboratory LIG, Grenoble – and PhD of João Lima).

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